

## Review Article

# Manual Physical Therapies for Carpal Tunnel Syndrome: A Narrative Review of Mechanisms, Techniques, and Evidence

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## Abstract

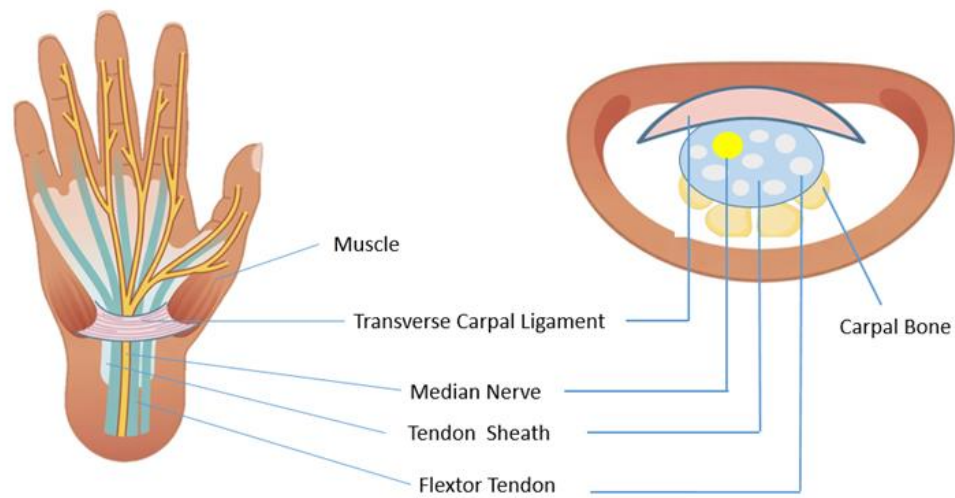
Carpal Tunnel Syndrome (CTS) is the conventional entrapment neuropathy, influencing millions worldwide and giving rise to pain, paresthesia, and functional impairment. Manual physical therapy has secured acknowledgement as an effective non-invasive approach. This scientific review provides a thorough review of key Manual Therapy (MT) techniques, counting soft-tissue mobilization (myofascial release, massage), carpal bone and wrist joint mobilizations, median nerve neurodynamic gliding, and proximal cervical/thoracic outlet interventions, further with standard procedures (8–12 sessions over 4–8 weeks, often combined with splinting and home exercises). A combination of systematic reviews and network meta-analyses exhibits moderate-to-large short-term advancement in pain severity and Boston Carpal Tunnel Questionnaire scores, with progression in nerve conduction studies. MT frequently ranks highest among non-invasive therapies for pain relief and outperforms splinting or exercise alone, while obtaining outcomes equivalent to surgery in medium- and long-term follow-up with fewer complications and lower costs. Intended procedures include biomechanical relief of the carpal tunnel, enhanced nerve excursion, neurophysiological modulation via dropping inhibitory pathways, and contextual effects. MT is optimal as a frontline intervention for mild-to-moderate CTS. Despite these facts, limitations include clinical diversity and short follow-up in many trials; current evidence strongly supports its combination into clinical pathways. Future research should focus on standardized protocols, long-term consequences, subgroup analyses, and cost-effectiveness studies to process patient selection and optimize dosing.

**Keywords:** Carpal tunnel syndrome, Manual therapy, Neurodynamic mobilization, Joint mobilization.

## 1. Introduction

Carpal Tunnel Syndrome (CTS) is the most prevalent entrapment neuropathy, responsible for the preponderance of vital mononeuropathies encountered in clinical practice. It arises from escalated compression of the median nerve as it traverses the narrow fibro-osseous carpal tunnel at the wrist (Aroori et al. 2008). Up to 70% of patients exhibit bilateral involvement; despite this, symptoms may be asymmetric. The condition affects 0.1–10% of the general adult population, with a clear female predominance (female-to-male ratio approximately 3:1) and high incidence between

40 and 60 years of age (“Carpal Tunnel Syndrome - Hand - Orthobullets,” 2026). Although occupational factors have long been implicated, repetitive wrist motions, forceful gripping, and vibration exposure contribute to higher prevalence and incidence in certain vocations, yet not all studies confirm a direct causal link. Established systemic risk factors include obesity, pregnancy, diabetes mellitus, hypothyroidism, and rheumatoid arthritis. Genetic predisposition plays a substantial role, with population-based studies demonstrating that CTS clusters within families in 17–39% of



**Figure 1: Palmar View of the Hand and Wrist Showing the Median Nerve Pathway through the Carpal Tunnel**

cases and co-occurs with inherited neuropathies such as Charcot-Marie-Tooth disease (Jiménez-del-Barrio et al. 2022). Anatomical developments that are often genetically determined, such as short stature, inherently smaller carpal tunnel dimensions, a thickened transverse carpal ligament, and square wrist morphology, further increase the vulnerability. Moreover, many comprehensive disorders, including diabetes and thyroid disease, themselves exhibit strong hereditary patterns (“Is Carpal Tunnel Genetic?” 2022).

Clinically, patients experience intermittent or persistent paresthesia, numbness, tingling, and aching pain strictly restricted to the median-nerve sensory distribution (thumb, index, middle, and radial half of the ring finger), particularly worsen at night and rapidly relieved by vigorous hand shaking (Ibrahim et al. 2012). As the neuropathy advances, motor involvement manifests as grip weakness, clumsiness, dropping objects, and, in advanced stages, visible thenar eminence atrophy. Severity is staged both clinically and electrodiagnostically into three categories: mild (purely sensory, intermittent symptoms without motor deficit), moderate (more frequent daytime

symptoms with mild-subjective weakness but preserved muscle bulk), and severe (constant sensory loss, objective motor impairment, and thenar atrophy) (“JAAOS - Journal of the American Academy of Orthopaedic Surgeons,” 2026). Although surgical CT release, whether open or endoscopic, delivers durable symptom relief in 75–90% of patients, it carries notable limitations (Louie et al. 2012). These include elevated direct and indirect costs (particularly with endoscopic techniques due to specialized equipment and operating-room time), perioperative complications occurring in 1–4% of cases (infection, hematoma, pillar pain, scar tenderness, and rare iatrogenic nerve injury), and symptom recurrence that may demand revision surgery in 1–10% of patients (Lane et al. 2021). Consequently, evidence-based guidelines advocate an initial trial of conservative management for mild-to-moderate CTS to overcome surgical risks while achieving comparable long-term functional outcomes. Among non-operative methods, nighttime wrist splinting, corticosteroid injections, activity modification, and therapeutic exercise, MT holds a noteworthy evidence-based position. Techniques such as cervical and carpal joint

mobilizations, targeted soft-tissue release, and median-nerve neurodynamic gliding consistently signify superior short-term reductions in pain and disability, equivalent medium- and long-term results to surgery, zero reported adverse events, and substantially lower overall cost (Fernández-de-Las Peñas et al. 2015). This narrative review synthesizes the current evidence regarding MT interventions for CTS, with particular emphasis on specific techniques, proposed neurophysiological mechanisms, documented clinical effectiveness across outcome domains, and priority areas for future research. The anatomical pathway of the median nerve through the carpal tunnel is depicted in Figure 1.

## **2. Carpal Tunnel Syndrome: Pathophysiology Relevant to Manual Therapy**

The CTS is progressive compression of the median nerve within the fibro-osseous carpal tunnel, where elevated interstitial pressure (often exceeding 30 mmHg) impairs epineural microcirculation, venous return, and axoplasmic flow (Joshi et al., 2022.). At pressures of 20–30 mmHg, epineural edema succeeds; beyond 60–80 mmHg, arteriolar occlusion occurs, leading to ischemia, demyelination, and eventual axonal degeneration if unrelieved (Ibrahim et al. 2012). This compression is vigorous, intensified with sustained wrist flexion/extension that narrows the tunnel volume by up to 30 %.

Locally, the transverse carpal ligament (flexor retinaculum) forms the non-compliant roof, while the nine flexor tendons and their synovium employ most of the tunnel contents. Synovial hypertrophy and subsynovial connective tissue fibrosis, directed by recurrent micro trauma or pervasive factors, represent the primary cause of idiopathic CTS, increasing tunnel pressure and restricting tendon-nerve gliding (Werthel et al. 2014). Proximal contributors further intensify vulnerability through the double-crush phenomenon: cervical

radiculopathy (particularly C6–C7) or thoracic outlet dysfunction impairs axoplasmic transport, rendering the median nerve more susceptible to distal entrapment and generating neurodynamic dysfunction that mediates mechanical stress peripherally (Russell 2008).

Inflammation initiates a vicious cycle of synovial edema, cytokine release, and progressive fibrosis, elevating intraneural pressure and reducing nerve compliance. Chronic ischemia promotes endoneurial fibrosis and perineural thickening, perpetuating symptoms even after pressure is relieved (Aboonq 2015).

These pathophysiological traits issue a clear rationale for MT. Joint mobilizations of the carpal bones and cervical spine directly lessen tunnel pressure and reinstitute normal gliding interfaces. Median-nerve neurodynamic gliding techniques enhance excursion, restore blood flow, break adhesions, and lessen intraneural edema without exacerbating compression (Rozmaryn et al. 1998), (Sheereen et al. 2022). Soft-tissue techniques targeting the flexor retinaculum and forearm musculature enhance vascularity and reduce fibrosis. Additionally, manual interventions modulate central sensitization, prompted by constant peripheral sensitive input from the compressed nerve, via subsidizing inhibitory pathways, producing rapid hypoalgesia over local outcomes (Fernández-de-Las-Peñas et al. 2020). Thus, MT addresses both the local compressive pathology and the proximal and central components, offering a mechanistically targeted, conservative approach for mild-to-moderate CTS.

## **3. Overview of Manual Physical Therapy Interventions for CTS**

MT sets out as a key non-invasive intervention by lessening mechanical pressure on the nerve, enhancing tissue mobility, reducing inflammation, and reinstating normal nerve and joint function (Jiménez-del-Barrio et al. 2022b).

**Table 1: Comparison of Common Manual Therapy Techniques for CTS**

Techniques	Primary Target	Key Benefits	Typical Session Time	Best Strategy of CST
<b>Soft Tissue Technique</b>	Forearm muscles and Fascia	Reduce tension and edema	8-12 min	Mild-Moderate
<b>Joint Mobilization</b>	Carpal bone and Wrist joint	Improve joint play and tunnel space	5-8 min	Moderate
<b>Neurodynamic Gliding</b>	Median nerve excursion	Reduce adhesion and mechanosensitivity	6-10 min	Any Stage
<b>Proximal (Cervical/TOS)</b>	Cervical spine and Thoracic outlet	Address the double crush contributor	5-8 min	With neck/shoulder signs.

These practical approaches are frequently incorporated with nerve gliding exercises, splinting, and alteration of routine (Du et al. 2022). Systematic reviews and clinical trials support their effectiveness in alleviating symptom severity and improving hand function, especially in mild-to-moderate CTS, often delaying or avoiding surgery (Donati et al. 2024).

**i. Soft Tissue Techniques**

Soft tissue mobilization straight off addresses tightness and limitations in the forearm flexors, flexor retinaculum, and surrounding fascia that contribute to escalating pressure within the carpal tunnel.

Myofascial delivers sustained gentle pressure or stretch to restricted areas for 60–90 seconds to release adhesions and enhance tissue extensibility. Massage techniques (effleurage, petrissage, and transverse friction) lessen hypertonicity in muscles such as flexor digitorum superficialis, profundus, and pronator teres, improve local blood flow, and reduce edema. Instrument-Assisted Soft Tissue Mobilization applies stainless-steel tools to observe and crush scar tissue or fascial restrictions with the median nerve pathway and volar wrist anatomy. These techniques are especially useful when patients have palpable

forearm tightness or post-inflammatory fibrosis (Jiménez-del-Barrio et al. 2022a).

**ii. Joint Mobilization**

Joint mobilization can rehabilitate normal arthrokinematics at the wrist and carpal bones, which can help to enhance available space in the carpal tunnel.

Specific carpal bone mobilizations cooperates dorsal and volar glides, distractions, and rotations of bones such as the lunate, capitate, trapezium, and hamate. These are executed with Grade II–III oscillatory movements. Wrist joint play method involves anterior-posterior glides, lateral glides, and longitudinal distraction at the radiocarpal joint. The goal is to enhance wrist flexion/extension mobility and lessen stiffness that may worsen median nerve compression. Mobilizations are requested cautiously to avoid provoking symptoms and are often introduced by soft tissue work to compose the tissues (Wolny et al. 2017).

**iii. Neurodynamic Techniques**

Neurodynamic techniques boost the excursion and alleviate tension on the median nerve as it proceeds through the cervical spine, brachial plexus, and carpal tunnel.

Median nerve sliding or “flossing” exercises merge consecutive movements of the neck, shoulder, elbow, wrist, and fingers. Slider

techniques intensify nerve excursion with the slightest tension (gentle, pain-free movement), while the tensioner approach gradually adds more neural loading. These are primarily performed inactively by the therapist and advance to active home programs. Structured gliding helps block or break intraneural adhesions, enhances nerve blood flow, and reduces mechanosensitivity, which is mainly beneficial when patients appear with tingling in sustained wrist positions (Núñez de Arenas-Arroyo et al. 2021).

#### **iv. Manual Therapy Targeting Proximal Structures**

As a consequence of the potential for “double-crush” phenomena, MT frequently deals with proximal sites of nerve compression or irritation. Cervical spine mobilization (lateral glides, rotations, or posterior-anterior glides at C5–C7 segments) can lessen the mentioned symptoms and enhance neural mobility from the core. Thoracic outlet release techniques involve soft tissue work on the scalene muscles and pectoralis minor, first rib mobilization (inferior glides), and clavicular mobilizations to open the costoclavicular and pectoralis minor spaces. These proximal interventions are desired when patients show positive upper limb tension tests, neck stiffness, or thoracic outlet signs that intensify hand symptoms (Peñas et al. 2015).

#### **v. Brief Comparison of Common Techniques**

A brief comparison of the common MT techniques for CTS is presented in Table 1. This placement provides a clear synthesis immediately after the individual technique descriptions and before discussing how they are applied in clinical protocols.

### **4. Evidence of Effectiveness**

Recent systematic reviews and network meta-analyses provide strong, high-level evidence that MT is an effective technique for acute CTS. These combinations invariably demonstrate clinically substantial improvements across

multidimensional outcome domains, with effect sizes often moderate to large, particularly for the temporary time period. MT techniques, predominantly soft-tissue mobilization, carpal joint mobilizations, and median nerve neurodynamics, commonly rank among the top-tier non-surgical options and compare potentially to surgery in the short-to-medium term.

Pain relief is the most constant reported benefit. A network meta-analysis of 49 randomized controlled trials (RCTs) involving 3,323 participants ranked MT highest for both short-term (surface under the cumulative ranking curve) (87.6%) and medium-term pain relief (99.3%), outperforming local steroid injections, platelet-rich plasma, shockwave therapy, and laser therapy (Chen et al. 2025). Earlier conventional meta-analyses strengthen this (Jiménez-del-Barrio et al. 2022b), integrated data from six RCTs (n=401) and reported a very large immediate post-treatment effect on pain intensity (standardized mean difference  $-2.13$ , 95% CI  $-2.39$  to  $-1.86$ ). Likewise, (Hernández-Sánchez et al. 2025) analyzed 9 trials and found a great relief (SMD  $-1.83$ , 95% CI  $-2.62$  to  $-1.03$ ). These short-term achievements are clinically remarkable and often significant to exercise only.

Functional improvement, measured mainly by the Boston Carpal Tunnel Questionnaire (BCTQ), is equally significant. (Jiménez-del-Barrio et al. 2022c) stated a substantial drop in symptom extremity (SMD  $-1.67$ , 95% CI  $-1.92$  to  $-1.43$ ) and moderate-to-large effect in functional status (SMD  $-0.89$ , 95% CI  $-1.08$  to  $-0.70$ ). (“(PDF) Effectiveness of Manual Therapy in Carpal Tunnel Syndrome” 2026) committed these findings with mean differences of  $-0.94$  points on the symptom severity scale and  $-0.88$  points overall on the BCTQ. Patients often report a reduction in nighttime paresthesia, enhanced grip during daily activities, and improved hand function within 4–6 weeks, results that lead to lessening disability (Yucel 2015).

Nerve conduction studies (NCS) exhibit more factors, but generally positive electrophysiological changes. (Jiménez-del-Barrio et al. 2022a) found remarkable development in sensory conduction velocity/latency (SMD  $-1.15$ , 95% CI  $-1.36$  to  $-0.93$ ) and a lesser but statistically substantial increase in motor conduction (SMD  $-0.19$ , 95% CI  $-0.40$  to  $-0.02$ ). (“(PDF) Effectiveness of Manual Therapy in Carpal Tunnel Syndrome” 2026) reported improvement in sensory conduction velocity (mean difference  $7.46$  m/s) and motor conduction velocity ( $1.85$  m/s), with reduced motor latency ( $-0.57$  ms). While not all cases showed homogenization of the NCS framework, the constant trend toward improved nerve conduction supports the mechanistic rationale of MT.

Comparison versus surgery shows that MT attains similar medium- and long-term results while contributing advantages in the short term. The landmark RCT by (Fernández-de-Las Peñas et al. 2015) randomized 120 women with CTS to MT versus carpal tunnel release surgery. In 12 months, both groups showed equal improvements in pain and function, and a 4-year follow-up confirmed constant outcomes. More recent syntheses align with this pattern. (Donati et al. 2024) A systematic review and meta-analysis show that MT provides faster short-term symptom relief and comparable long-term outcomes to surgery, with fewer complications and lower cost. Several 2024–2025 trials reinforce that MT can be provided as a preferred option, conserving surgery for severe cases.

Comparison with other conservative treatments further reinforces MT's position. In the 2025 network meta-analysis by (Chen et al. 2025), MT was classified first among 11 non-invasive interventions for pain relief. It outmatched low-level laser, shockwave, and splinting alone, and carried out at least as well as corticosteroid injections in the medium term. Neurodynamic-specific reviews (Núñez de Arenas-Arroyo et al. 2021) also indicate appreciative effects on pain

and function when gliding techniques are added to best practices.

Despite the positive outcomes, there are certain limitations. Most outcomes derive from small-to-moderate sample sizes (many trials  $n < 60$ ), leading to wide confidence intervals in some analyses. Follow-up durations are primarily short-term ( $\leq 3$  months), with fewer studies with 6–12 months. High statistical and clinical heterogeneity (75–96%) arises from variability in MT protocols (techniques, dosage, and session frequency), patient severity, and outcome measurement timing. Blinding of therapists and participants is naturally challenging, and long-term cost-effectiveness data remain restricted. Technique quality also varies; studies exhibiting isolated neurodynamic or soft-tissue approaches show greater satisfaction than multimodal or poorly standardized techniques.

## 5. Discussion

MT emerges as an efficacious, evidence-based conventional technique for CTS. Outcomes on the BCTQ and nerve conduction studies rival or exceed those of splinting, injections, or other non-surgical modalities, while medium- and long-term outcomes match surgical decompression without the related risks or costs. Proposed mechanisms Advantages function through interconnected biomechanical, neurophysiological, and contextual routes. Biomechanically, carpal bone mobilizations and soft-tissue techniques increase the accessible space within the carpal tunnel, lessen intratunnel pressure, and reinstate normal gliding of the median nerve and flexor tendons. Neurodynamic exercises specifically enhance longitudinal and transverse excursion of the median nerve, reduce epineural tethering, and advance intraneural fluid dispersion, thereby lessening oedema and mechanical compression. Neurophysiologically, the mechanical forces put in during treatment trigger a cascade of peripheral and central responses, including activation of descending inhibitory pathways,

modulation of neuroinflammation, and improved nerve conduction, leading to quick habituation and analgesia. A widely cited comprehensive model explains how these peripheral inputs initiate central nervous system changes responsible for sustained symptom relief (Bialosky et al. 2009). Contextual and placebo effects further amplify outcomes through therapeutic alliance, patient expectation, and the hands-on nature of care, which can modulate pain perception independently of mechanical changes.

**Clinical implications:** MT is ideal for patients with mild-to-moderate CTS (electrodiagnostic grades 1–3), where it can be used as an initial intervention or as a bridge to surgery. It provides rapid symptom relief (often within 4–6 weeks), making it ideal for individuals who desire to avoid or delay operational management. When combined with night splinting, home nerve-gliding exercises, ergonomic modifications, and strengthening, this process has a combined effect and enables patients to use self-management strategies. In clinical practice, therapists should screen for proximal contributors (cervical or thoracic outlet dysfunction) and individualize dosage based on irritability and chronicity.

**Strengths and weaknesses of current evidence.** Strengths include the coherence in evidence across multiple exceptional meta-analyses, the non-detrimental safety profile, and exhibited cost-effectiveness. MT is significantly more economical than surgery while remitting comparable or superior temporary results, with lower absenteeism and fewer additional healthcare visits (Jiménez-del-Barrio et al. 2022a). Weaknesses mirror those noted in the systematic review: significant diversity in protocols, prevalence of small sample sizes, and impracticability of blinding inherent to hands-on management.

**Gaps and future directions.** Critical gaps remain. Eventual consequences beyond 12 months are understudied, with few milestone cases. Dose-

response relationships (optimal number, frequency, and duration of sessions) and explicit patient-selection criteria require clarification. Although one exceptional economic analysis validates providing maximum value at 1 year, current cost-utility studies across diversified healthcare systems and patient profiles are required. Future research should also integrate mechanistic imaging (e.g., ultrasound or MRI) to quantify viable changes in nerve excursion, tunnel volume, and intraneural oedema.

## 6. Conclusion

MT interventions exhibit optimistic short- to medium-term benefits for pain relief and functional optimization in patients with CTS. Systematic reviews and meta-analyses constantly disclose moderate-to-large effect sizes on pain severity and BCTQ scores that are often equivalent or superior to other non-surgical interventions, mainly in the early stage of treatment (within 4–8 weeks). Electrophysiological advancement on nerve conduction studies further supports the clinical significance of these gains, while medium- and long-term outcomes remain equivalent to surgical relief.

These evidences place MT as a rational, evidence-based primary intervention before in view of surgery, especially in mild-to-moderate CTS. Its non-destructive nature, high safety profile, rapid symptom relief, and lower cost make it an ideal prime or connecting approach that licenses patients with self-management strategies and may alleviate the need for operative control.

Future research management should foreground larger, multisite randomized controlled trials with systematized protocols, longer follow-up periods (>12 months), and demanding subgroup analyses according to symptom severity, duration, and presence of proximal contributors. Additional studies on optimal dose-response relationships, combination therapies (MT plus

splinting/exercise), and cost-effectiveness across assorted populations will reinforce clinical regulations and further explain the explicit function of MT within contemporary CTS care pathways.

### Conflict of Interest

All the authors declare no conflicts of interest.

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### Study Approval

NA

### Consent Forms

NA

### Authors Contributions

Fatima Saleem contributed to the conceptualization and initial drafting of this review article, while Hasnain Sabir contributed to critical revision and refinement of the manuscript. Both authors approved the final version.

### Data Availability

All the data relevant to this study is with the authors.

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### References

Aboonq, Moutasem S. 2015. "Pathophysiology of Carpal Tunnel Syndrome." *Neurosciences* 20 (1): 4–9. <https://pmc.ncbi.nlm.nih.gov/articles/PMC4727604/>.

Aroori, Somaiah, and Roy A. J. Spence. 2008. "Carpal Tunnel Syndrome." *The Ulster Medical Journal* 77 (1): 6–17.

Bialosky, Joel E., Mark D. Bishop, Don D. Price, Michael E. Robinson, and Steven Z. George. 2009. "The Mechanisms of Manual Therapy in the Treatment of Musculoskeletal Pain: A Comprehensive Model." *Manual Therapy* 14 (5): 531–38. <https://doi.org/10.1016/j.math.2008.09.001>.

"Carpal Tunnel Syndrome - Hand - Orthobullets." March 4, 2026. <https://www.orthobullets.com/hand/6018/carpal-tunnel-syndrome>.

Chen, Yuanhao, Bing Han, Xin Zhang, et al. 2025. "Conservative Treatments of Carpal Tunnel Syndrome: A Systematic Review and Network Meta-Analysis." *Archives of Physical Medicine and Rehabilitation* 106 (9): 1447–58. <https://doi.org/10.1016/j.apmr.2025.04.002>.

Aboonq, Moutasem S. 2015. "Pathophysiology of Carpal Tunnel Syndrome." *Neurosciences* 20 (1): 4–9. <https://pmc.ncbi.nlm.nih.gov/articles/PMC4727604/>.

Aroori, Somaiah, and Roy A. J. Spence. 2008. "Carpal Tunnel Syndrome." *The Ulster Medical Journal* 77 (1): 6–17.

Bialosky, Joel E., Mark D. Bishop, Don D. Price, Michael E. Robinson, and Steven Z. George. 2009. "The Mechanisms of Manual Therapy in the Treatment of Musculoskeletal Pain: A Comprehensive Model." *Manual Therapy* 14 (5): 531–38. <https://doi.org/10.1016/j.math.2008.09.001>.

"Carpal Tunnel Syndrome - Hand - Orthobullets." n.d. Accessed March 4, 2026. <https://www.orthobullets.com/hand/6018/carpal-tunnel-syndrome>.

Chen, Yuanhao, Bing Han, Xin Zhang, et al. 2025. "Conservative Treatments of Carpal Tunnel Syndrome: A Systematic Review and Network Meta-Analysis." *Archives of Physical Medicine and*

- Rehabilitation 106 (9): 1447–58. <https://doi.org/10.1016/j.apmr.2025.04.002>.
- Donati, Danilo, Paolo Boccolari, and Roberto Tedeschi. 2024. “Manual Therapy vs. Surgery: Which Is Best for Carpal Tunnel Syndrome Relief?” *Life* 14 (10). <https://doi.org/10.3390/life14101286>.
- Du, Jihang, Qiang Yuan, Xiao-Yan Wang, et al. 2022. “Manual Therapy and Related Interventions for Carpal Tunnel Syndrome: A Systematic Review and Meta-Analysis.” *Journal of Integrative and Complementary Medicine* 28 (12): 919–26. <https://doi.org/10.1089/jicm.2022.0542>.
- Fernández-de-Las Peñas, César, Ricardo Ortega-Santiago, Ana I. de la Llave-Rincón, et al. 2015. “Manual Physical Therapy Versus Surgery for Carpal Tunnel Syndrome: A Randomized Parallel-Group Trial.” *The Journal of Pain* 16 (11): 1087–94. <https://doi.org/10.1016/j.jpain.2015.07.012>.
- Fernández-de-Las-Peñas, César, José L. Arias-Buría, Ricardo Ortega-Santiago, and Ana I. De-la-Llave-Rincón. 2020. “Understanding Central Sensitization for Advances in Management of Carpal Tunnel Syndrome.” *F1000Research* 9: F1000 Faculty Rev-605. <https://doi.org/10.12688/f1000research.22570.1>.
- HERNÁNDEZ-SÁNCHEZ, Sergio, José V. SEGURA-HERAS, Paula ANDREU-CONDE, Manuel ALBORNOZ-CABELLO, Luis ESPEJO-ANTÚNEZ, and José V. TOLEDO-MARHUENDA. 2025. “Effect of Home Exercise Programs in Patients with Non-Tears Rotator Cuff-Related Shoulder Pain: A Systematic Review and Meta-Analysis.” *European Journal of Physical and Rehabilitation Medicine* 61 (4): 655–68. <https://doi.org/10.23736/S1973-9087.25.08607-1>.
- Ibrahim, I., W. S. Khan, N. Goddard, and P. Smitham. 2012. “Carpal Tunnel Syndrome: A Review of the Recent Literature.” *The Open Orthopaedics Journal* 6 (February): 69–76. <https://doi.org/10.2174/1874325001206010069>.
- “Is Carpal Tunnel Genetic?” 2022. January 17. <https://www.medicalnewstoday.com/articles/is-carpal-tunnel-syndrome-genetic>.
- “JAAOS - Journal of the American Academy of Orthopaedic Surgeons.” n.d. Accessed March 4, 2026. <https://journals.lww.com/jaaos/pages/articleviewer.aspx?year=2007&issue=09000&article=00004&type=Fulltext>.
- Jiménez-del-Barrio, Sandra, Aida Cadellans-Arróniz, Luis Ceballos-Laita, et al. 2022a. “The Effectiveness of Manual Therapy on Pain, Physical Function, and Nerve Conduction Studies in Carpal Tunnel Syndrome Patients: A Systematic Review and Meta-Analysis.” *International Orthopaedics* 46 (2): 301–12. <https://doi.org/10.1007/s00264-021-05272-2>.
- Jiménez-del-Barrio, Sandra, Aida Cadellans-Arróniz, Luis Ceballos-Laita, et al. 2022b. “The Effectiveness of Manual Therapy on Pain, Physical Function, and Nerve Conduction Studies in Carpal Tunnel Syndrome Patients: A Systematic Review and Meta-Analysis.” *International Orthopaedics* 46 (2): 301–12. <https://doi.org/10.1007/s00264-021-05272-2>.
- Jiménez-del-Barrio, Sandra, Aida Cadellans-Arróniz, Luis Ceballos-Laita, et al. 2022c. “The Effectiveness of Manual Therapy on Pain, Physical Function, and Nerve Conduction Studies in Carpal Tunnel Syndrome Patients: A Systematic Review and Meta-Analysis.” *International*

- Orthopaedics 46 (2): 301–12. <https://doi.org/10.1007/s00264-021-05272-2>.
- Joshi, Aditya, Karan Patel, Aleem Mohamed, et al. 2022. "Carpal Tunnel Syndrome: Pathophysiology and Comprehensive Guidelines for Clinical Evaluation and Treatment." *Cureus* 14 (7): e27053. <https://doi.org/10.7759/cureus.27053>.
- Lane, Jennifer C. E., Richard S. Craig, Jonathan L. Rees, et al. 2021. "Serious Postoperative Complications and Reoperation after Carpal Tunnel Decompression Surgery in England: A Nationwide Cohort Analysis." *The Lancet. Rheumatology* 3 (1): e49–57. [https://doi.org/10.1016/S2665-9913\(20\)30238-1](https://doi.org/10.1016/S2665-9913(20)30238-1).
- Louie, Dexter, Brandon Earp, and Philip Blazar. 2012. "Long-Term Outcomes of Carpal Tunnel Release: A Critical Review of the Literature." *Hand (New York, N.Y.)* 7 (3): 242–46. <https://doi.org/10.1007/s11552-012-9429-x>.
- Núñez de Arenas-Arroyo, Sergio, Iván Cavero-Redondo, Ana Torres-Costoso, Sara Reina-Gutiérrez, Celia Álvarez-Bueno, and Vicente Martínez-Vizcaíno. 2021. "Short-Term Effects of Neurodynamic Techniques for Treating Carpal Tunnel Syndrome: A Systematic Review With Meta-Analysis." *The Journal of Orthopaedic and Sports Physical Therapy* 51 (12): 566–80. <https://doi.org/10.2519/jospt.2021.10533>.
- "(PDF) Effectiveness of Manual Therapy in Carpal Tunnel Syndrome: Systematic Review and Meta-Analysis." 2026. ResearchGate, ahead of print, March 4. <https://doi.org/10.12800/ccd.v19i59.2025>.
- Peñas, César Fernández-de-las, Ricardo Ortega-Santiago, Ana I. de la Llave-Rincón, et al. 2015. "Manual Physical Therapy Versus Surgery for Carpal Tunnel Syndrome: A Randomized Parallel-Group Trial." *The Journal of Pain* 16 (11): 1087–94. <https://doi.org/10.1016/j.jpain.2015.07.012>.
- Rozmaryn, L. M., S. Dovel, E. R. Rothman, K. Gorman, K. M. Olvey, and J. J. Bartko. 1998. "Nerve and Tendon Gliding Exercises and the Conservative Management of Carpal Tunnel Syndrome." *Journal of Hand Therapy: Official Journal of the American Society of Hand Therapists* 11 (3): 171–79. [https://doi.org/10.1016/s0894-1130\(98\)80035-5](https://doi.org/10.1016/s0894-1130(98)80035-5).
- Russell, Brent S. 2008. "Carpal Tunnel Syndrome and the 'Double Crush' Hypothesis: A Review and Implications for Chiropractic." *Chiropractic & Osteopathy* 16 (April): 2. <https://doi.org/10.1186/1746-1340-16-2>.
- Sheereen, Fauzia Javed, Bibhuti Sarkar, Pallavi Sahay, et al. 2022. "Comparison of Two Manual Therapy Programs, Including Tendon Gliding Exercises as a Common Adjunct, While Managing the Participants with Chronic Carpal Tunnel Syndrome." *Pain Research & Management* 2022 (June): 1975803. <https://doi.org/10.1155/2022/1975803>.
- Werthel, Jean-David R., Chunfeng Zhao, Kai-Nan An, and Peter C. Amadio. 2014. "Carpal Tunnel Syndrome Pathophysiology: Role of Subsynovial Connective Tissue." *Journal of Wrist Surgery* 3 (4): 220–26. <https://doi.org/10.1055/s-0034-1394133>.
- Wolny, Tomasz, Edward Saulicz, Paweł Linek, Michael Shacklock, and Andrzej Myśliwiec. 2017. "Efficacy of Manual Therapy Including Neurodynamic Techniques for the Treatment of Carpal Tunnel Syndrome: A Randomized Controlled Trial." *Journal of Manipulative and Physiological Therapeutics* 40 (4): 263–72.

<https://doi.org/10.1016/j.jmpt.2017.02.004>

4.

Yucel, Hulya. 2015. "Factors Affecting Symptoms and Functionality of Patients with Carpal Tunnel Syndrome: A Retrospective Study." *Journal of Physical Therapy Science* 27 (4): 1097–101. <https://doi.org/10.1589/jpts.27.1097>.

Zubair, Muhammad, Perviz Khan, Uzair Ahmad, Syed Zain Ul Abidin, Saeed Ullah Shah, and Abeer Kazmi. 2022. "Frequency of Carpal Tunnel Syndrome Among Dentists Working in Tertiary Care Hospitals of Peshawar, Pakistan." *Ann Jinnah Sindh Med Uni* no. 8 (1).