Review

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Rehabilitation approach to carpal tunnel syndrome: from the literature review to the clinical practice

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Introduction: Carpal tunnel syndrome (CTS) is the most common peripheral nerve entrapment syndrome. In the literature, several conservative treatments have been proposed but, to our notice, a practical and ready-to-use guide as regards different rehabilitation techniques is lacking. In this sense, by combining scientific evidence and expert opinion, the present manuscript aims to display the conservative and rehabilitation approach to this challenging pathology.

Methods: From a total of 145 items identified, the authors analyzed 79 articles—excluding studies that had recruited patients without clinical and/or instrumental diagnosis of CTS or those who had undergone surgery. Four categories of nonsurgical approaches have been defined; injections, rehabilitation techniques, orthoses, and physical therapies.

Results: Carpal tunnel injection with 5% dextrose, night wrist orthosis, and extracorporeal shockwave therapy seemed to be the most effective nonsurgical treatment in CTS. Considering the poor description of specific upper limb rehabilitation techniques in the literature, an in-depth focus has also been provided based more on the authors' experience in hand rehabilitation.

Conclusions: Future clinical studies are awaited to establish standardized conservative protocols whereby the injection dose/technique, physical therapy, and the specific rehabilitation technique are reported. Further, a better understanding of the dynamic relationship between the median nerve and the nearby soft tissues inside the tunnel (eg, perineural loose connective tissue) would be noteworthy to optimize the treatment outcome and the hand function in the long term.

Keywords: Median nerve, Entrapment, Hand, Splint, Physical therapy, Intervention, Rehabilitation

Introduction

Carpal tunnel syndrome (CTS), ie, compression of the median nerve (MN) inside the carpal tunnel, is the most common entrapment syndrome of the peripheral nerves, and it affects almost 10% of the population[1,2]. At the wrist, the MN courses through the carpal tunnel, which is formed by the carpal bones on its inferior, medial, and lateral sides; and by the transverse carpal ligament on its roof. Inside the tunnel, the flexor tendons (and their synovial sheaths), the subsynovial tissue, and the filling adipose tissue accompany the MN (Fig. 1)[3]. CTS is either idiopathic or secondary to several pathological conditions such as rheumatoid arthritis, hypothyroidism, and diabetes[4,5].

The symptoms are mainly related to increased pressure inside the tunnel—due to different pathological conditions such as flexor tenosynovitis and/or tendinosis. Likewise, thickening of the subsynovial tissue, edema, or fibrotic involution of the filling adipose tissue may also change the pressure inside the carpal

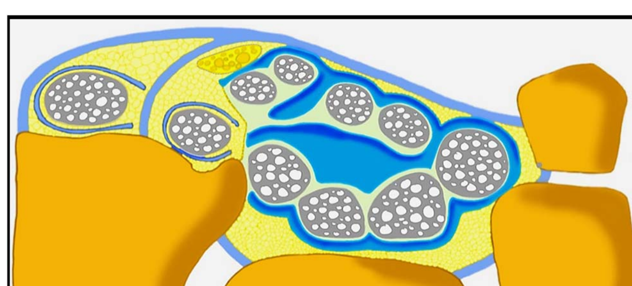

Figure 1. *Anatomical structures within the carpal tunnel*. The median nerve, flexor tendons, and associated connective tissues are enclosed by the transverse carpal ligament and carpal bones.

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tunnel. Interestingly, not only the MN compression but also its reduced mobility inside the tunnel seems to affect the clinical findings[6]. In this sense, the role of dynamic ultrasound (US) examination is being much more important for the assessment of MN gliding in CTS[5,6].

Concerning the diagnosis; electrodiagnostic tests and US examinations are crucial/complementary in daily practice[7]. While the former provides functional information, ie, a focal slowdown or blockage of conduction of the fibers of the MN through the carpal tunnel, the latter displays morphological data as regards the MN as well as the nearby soft tissues. Hypoechoic enlargement (ie, neural edema) proximal to the entrapment site is usually quantified using transverse scanning, whereby a cross-sectional area (CSA) of >10 mm^2 is usually considered pathological[2]. In the longitudinal plane, the MN shows an "hourglass" appearance secondary to focal stenosis beneath the transverse carpal ligament[8]. In the (sub)acute phase, the MN appears hypoechoic due to the edematous changes of the nerve fascicles. Instead, in the chronic phase, the MN usually presents a "white" pattern due to a decreased number of nerve fascicles and hypertrophy of the hyperechoic interfascicular epineurium[9].

In the pertinent literature, several conservative treatments have been described for CTS. Herewith, to the authors' best knowledge, a practical and ready-to-use guide addressing different rehabilitation approaches is lacking. As such, merging the relevant scientific evidence and the authors' experience, the present narrative review aims to display a substantial nonsurgical approach in CTS[10].

Carpal tunnel syndrome (CTS) presents with a characteristic set of symptoms and clinical findings, which can be assessed through history-taking, physical examination, and diagnostic testing. Electrodiagnostic studies (EDS), ultrasound (US), and, in specific cases, magnetic resonance imaging (MRI) are used to confirm the diagnosis and assess severity.

Table 1 summarizes the primary clinical features, while Table 2 outlines the diagnostic criteria based on different modalities.

Materials and methods

A substatial literature search was performed using Cochrane Library, PubMed, Scopus, and Google Scholar with the following keyword combinations; "carpal tunnel syndrome and conservative treatment," "carpal tunnel syndrome and nonsurgical treatment," "carpal tunnel syndrome and rehabilitation," and "carpal tunnel syndrome and physical therapy." Our review did not include any systemic pharmacological treatment or nutraceutical approach.

We included all experimental and original articles, case reports, randomized controlled trials, systematic reviews, meta-analyses, and book chapters published in the last 16 years from November 2007 until December 2023. Papers written in English were reviewed if their full texts were available. We excluded studies that had recruited patients without clinical and/or instrumental diagnosis of CTS or those who had undergone surgery. Overall, out of 240 articles identified, 79 were analyzed for this review.

During the selection process, we examined whether the included studies evaluated multimodal treatment approaches, ie, combinations of injections, rehabilitation, orthoses, and physical therapies. Approximately 35% of the reviewed studies implemented at least 2 nonsurgical interventions. Among these, the most common combinations included:

- Corticosteroid or 5% dextrose injections + wrist orthosis (40% of multimodal studies)
- Neurodynamic mobilization + tendon gliding exercises (30%)
- Extracorporeal shockwave therapy (ESWT) + manual therapy (20%)
- Other combinations (10%), such as PRP injections with rehabilitation programs

These multimodal approaches aimed to enhance therapeutic efficacy by addressing different pathophysiological mechanisms, such as neural compression, inflammation, and perineural fibrosis.

In addition, we considered whether the studies included patients with prior treatment failures. Among the reviewed studies, 28% explicitly reported recruiting patients who had not responded to previous conservative treatments (eg, splinting or manual therapy) before enrolling in injection-based trials. This highlights the relevance of alternative nonsurgical options for refractory CTS cases.

Aetiologies of CTS in the reviewed studies

CTS is commonly classified as idiopathic or secondary, with secondary forms linked to systemic or local predisposing factors. Table 3 summarizes the distribution of CTS aetiologies across the included studies.

Results

The authors have defined 4 categories of conservative management; injections, rehabilitation procedures, orthoses, and physical therapies.

Criteria for Improvement and Follow-Up Intervals in the Reviewed Studies

The criteria for improvement varied among the reviewed studies but were generally based on a combination of clinical, functional, and electrophysiological outcomes. The most commonly reported measures included:

- Pain reduction: Visual Analog Scale (VAS) or Numerical Rating Scale (NRS), with a clinically meaningful improvement

Table 1

Summary of clinical findings in CTS.

Category	Clinical Findings
Symptoms	Nocturnal pain, paresthesia in the median nerve distribution (thumb, index, middle fingers), hand weakness, clumsiness, symptom exacerbation with wrist flexion (Phalen's test)
Physical exam	Tinel sign (paresthesia on median nerve percussion), Phalen test (symptom reproduction after 30–60 s of wrist flexion), hand grip weakness, atrophy of thenar eminence in severe cases
Functional impact	Difficulty in grasping objects, impaired fine motor skills, reduced sensation, frequent object dropping

Table 2

Diagnostic criteria for CTS based on imaging and electrodiagnostics.

Modality	Diagnostic Criteria
Electrodiagnostic studies (EDS)	Prolonged distal motor latency (> 4.0 ms), reduced sensory conduction velocity (< 40 m/s), abnormal comparative studies (median vs. ulnar nerve at the wrist)
Ultrasound (US)	Median nerve cross-sectional area (CSA) > 10 mm² at the wrist, loss of normal fascicular echotexture, increased nerve stiffness on elastography, reduced mobility on dynamic US
Magnetic resonance imaging (MRI)	Median nerve swelling proximal to the carpal tunnel, signal hyperintensity in T2-weighted images, thickening of transverse carpal ligament in chronic cases

typically defined as a reduction of at least 2 points on a 10-point scale.

- Functional improvement: Boston Carpal Tunnel Questionnaire (BCTQ) and Disabilities of the Arm, Shoulder, and Hand (DASH) scores, with significant functional recovery considered as a 20%–30% reduction in disability scores.
- Electrophysiological changes: Decrease in median nerve distal motor latency (> 0.5 ms improvement), increased sensory conduction velocity (> 5 m/s improvement), and normalization of sensory nerve action potential amplitudes.
- Ultrasound findings: Reduction in median nerve cross-sectional area (CSA) at the wrist (> 1 mm² decrease), improved nerve mobility on dynamic ultrasound, and normalization of echotexture.
- Patient satisfaction and quality of life: Assessed using global rating scales and return to work/activity status.

Follow-up intervals

Follow-up duration varied significantly across studies, ranging from short-term (4–6 wk) to long-term (6–12 mo). The distribution of follow-up assessments was as follows:

- 4–6 weeks: 70% of studies reported short-term outcomes, mainly focusing on early pain reduction and functional improvement.
- 12 weeks (3 mo): 55% of studies included a mid-term follow-up to assess sustained functional recovery.
- 6 months: 35% of studies evaluated medium-term effects, particularly for injections and rehabilitation techniques.
- 12 months: 20% of studies included long-term assessments, primarily for injections and multimodal interventions.

Injections

Several authors have demonstrated the efficacy of corticosteroid injections in the acute phase of mild to moderate CTS[11]. Recently, 5% dextrose in water (D5W) and platelet-rich plasma (PRP) have been proposed as alternative injectables with promising clinical outcomes[12–15]. While their different volumes have been investigated, the hydrodissection technique for releasing adhesions between the epifascicular epineurium and the surrounding soft tissues is still a matter of debate.

Table 3

Distribution of CTS etiologies in reviewed studies.

Etiology	% of patients (range)	Common Associated Conditions
Idiopathic CTS	60–70	No identifiable cause
Diabetes-related CTS	10–15	Peripheral neuropathy, microvascular changes
Rheumatoid Arthritis	5–10	Synovial inflammation, joint deformity
Hypothyroidism	3–7	Myxedema-induced nerve compression
Pregnancy-related CTS	2–5	Hormonal changes, fluid retention
Post-traumatic CTS	1–3	Fractures, postsurgical fibrosis

Two main US-guided injection techniques have been described in the literature. The in-plane approach using an ulnar-to-radial (or vice versa) technique allows performing the perineural injection using a short-axis view of the MN. Using a single entry point, the needle can be inserted inside the transverse carpal ligament-MN interface or the flexor tendons-MN interface (Fig. 2). Real-time circumferential spread around the nerve can be observed during the procedure. Instead, the in-plane technique with a distal-to-proximal approach can only target the transverse carpal ligament-MN interface, as it visualizes the nerve trunk in a longitudinal view (Fig. 2)[16,17]. Corticosteroid injections remain the most commonly used treatment for mild to moderate CTS, with triamcinolone acetonide (20–40 mg), methylprednisolone (20–40 mg), and dexamethasone (4–8 mg) being the most frequently administered. These are typically diluted in 1–2 mL of local anesthetic or saline and are usually given as a single injection, with symptom relief lasting 3–6 months.

D5W injections, increasingly used for their neuroprotective effects, are commonly administered in volumes of 5–10 mL via hydrodissection to reduce perineural adhesions. Unlike corticosteroids, D5W is often injected weekly for 4–6 sessions, though some studies report benefits from a single injection with possible reinforcement at 4–6 weeks.

PRP explored for its regenerative potential, is typically injected in volumes of 3–5 mL, with platelet concentrations of 3–5 times baseline levels. Most studies report a single injection, with some offering a second dose at 4 weeks if symptoms persist. However, variability in PRP preparation remains a limitation.

Among the reviewed studies, 40% investigated corticosteroids (n ≈ 850 patients), 27% examined D5W (n ≈ 600), and 19% focused on PRP (n ≈ 400). Other injectable therapies, such as ozone and hyaluronic acid, were studied in 14% of cases. While corticosteroids remain the first-line injectable, emerging evidence supports D5W and PRP as alternative options, particularly for chronic or recurrent CTS, though further research is needed to define optimal protocols. A comparative summary of the effectiveness of different conservative treatments in terms of pain reduction, functional improvement, and follow-up duration is provided in Table 4.

Rehabilitation procedures

Systematic reviews and meta-analyses widely confirmed the effectiveness of rehabilitation techniques (eg manual therapy and neurodynamic mobilizations) for improving pain, hand function,

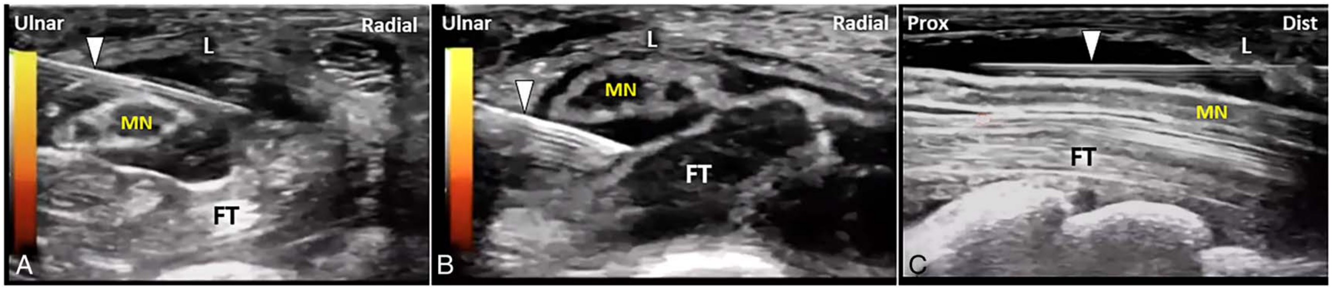

Figure 2. *Ultrasound-guided injection approaches for CTS*. Short-axis and long-axis in-plane techniques allow accurate perineural delivery of the injectate around the median nerve.

and MN electrophysiological parameters of CTS patients[18]. Among the reviewed studies, manual therapy was investigated in 35% of cases, including ~750 patients, while neurodynamic mobilization was examined in 30% of studies, involving around 650 patients. A further 20% of studies combined both techniques, suggesting that an integrated approach may provide superior symptom relief and functional recovery.

The duration, frequency, and number of sessions varied across studies. Most protocols applied rehabilitation techniques twice per week over a period of 4–8 weeks, with individual sessions lasting 20–30 minutes. Some studies extended treatment up to 12 weeks, particularly when combined with other conservative therapies, such as orthoses or physical modalities.

Patient demographics showed that the majority of subjects were between 40 and 65 years old, with a higher prevalence in women (~70%). Regarding CTS etiology, idiopathic CTS accounted for 60%–70% of cases, while secondary CTS was observed in 30%–40%, with diabetes (10%–15%), hypothyroidism (5%–10%), and rheumatoid arthritis (5%–10%) being the most frequent underlying conditions.

Manual therapy

Manual therapy is an umbrella medical term referring to different techniques such as soft tissue mobilization, passive joint mobilization, and tendon gliding exercises. Deep friction and myofascial release are the most commonly applied soft tissue mobilization techniques in clinical practice. They improve local perfusion of the MN and flexor tendons, promote drainage of fluids and local metabolism, and reduce soft tissue stiffness (Table 5)[19]. Tendon gliding exercises (Fig. 3) present 5 standardized positions of the hand: straight, hook, fist, tabletop, and straight fist positions, and they aim to reduce the pressure inside the carpal tunnel and counteract the perineural adhesions (Table 5)[20]. These manual therapies are considered to effectively improve pain and hand function also in CTS patients waiting for surgery or those with contraindications to the surgical approach[21]. Several authors proposed variable combinations of tendon gliding exercises and other conservative approaches, eg, neural mobilization techniques and splinting[22]. For instance, Horng et al[23] demonstrated that tendon gliding exercises could be better than specific neural gliding exercises in CTS patients using splints[24–26].

Manual therapy was examined in 35% of the reviewed studies, involving ~750 patients. The treatment duration typically ranged from 4 to 8 weeks, with sessions conducted twice per week and lasting 20–30 minutes. Some studies extended the intervention up to 12 weeks, particularly when combined with tendon gliding exercises or neurodynamic mobilization[22,27].

The patient population primarily consisted of women (70%), aged 40–65 years, with idiopathic CTS accounting for the majority of cases (60%–70%). Secondary CTS was observed in 30%–40% of patients, most frequently associated with diabetes (10%–15%), hypothyroidism (5%–10%), or rheumatoid arthritis (5%–10%).

To maintain consistency with other treatment sections, the description of manual therapy techniques has been streamlined[28]. The reviewed studies primarily focused on soft tissue mobilization[29], deep friction massage, joint mobilization, and tendon gliding exercises, aimed at improving median nerve mobility[30] and reducing perineural adhesions[31–33]. While some

Table 4

Summary of treatment outcomes in CTS.

Treatment approach	Pain reduction (%)	Functional improvement (%)	Follow-up duration	Notes
Corticosteroid injection	30–50	20–40	3–6 mo	Rapid symptom relief but short-lived benefits
5% dextrose injection (D5W)	40–60	30–50	6–12 mo	Promotes perineural adhesion release, longer-lasting benefits
PRP injection	30–50	20–40	6–12 mo	Potential regenerative effects, variable outcomes
Manual therapy	20–40	20–35	4–8 wk	Includes soft tissue mobilization and joint techniques
Neurodynamic mobilization	25–50	30–50	6–12 wk	Improves nerve mobility, reduces intraneural pressure
Night wrist orthosis	20–40	15–30	4–6 wk	Best for mild-moderate CTS, reduces wrist flexion stress
Extracorporeal shockwave therapy (ESWT)	30–50	20–40	4–6 wk	Potential tissue remodeling effect
Ultrasound therapy	20–40	15–30	4–6 wk	Conflicting evidence, better in multimodal approaches
Laser therapy	20–35	10–30	4–6 wk	Limited evidence for standalone effectiveness
Kinesiotaping	10–30	10–25	4 wk	Short-term relief, often used as an adjunct therapy

Table 5

Rehabilitation techniques for CTS.

Technique	Biological Effects
Soft tissue mobilization*	↑ drainage of fluids, ↓ soft tissue stiffness, ↑ soft tissue vascularization, ↑ local metabolism, ↑ release of local adhesions
Tendon gliding exercises	↓ pressure inside the carpal tunnel, ↓ perineural adhesions (between the epineurium and the synovial sheath of the flexor tendons)
Neurodynamic maneuvers	Sliding techniques (acute phase of CTS)
	↑ drainage of fluids, ↓ fascicular/extra-fascicular edema, ↓ intra-neural pressure, ↑ nerve perfusion, ↑ axoplasmic flow (oscillatory movements)
	Tensioning techniques (chronic phase of CTS)
	↓ perineural adhesions, ↑ neural gliding, ↓ intraneural fibrosis

*eg, deep friction massage and myofascial release.

studies reported positive outcomes with specific techniques[34,35], the heterogeneity of methods makes direct comparisons challenging[36] (Figs. 4 and 5).

Orthoses

Prolonged postures in extreme extension/flexion of the wrist increase the pressure within the carpal tunnel[37]. As such, wrist orthosis, tendon gliding exercises, and neural mobilization are often combined in the conservative management of CTS patients[38].

Biomechanically, orthosis maximizes the inner carpal tunnel volume and minimizes MN compression by realigning the wrist joint (Table 6)[39]. Several authors recommend a brace that positions the wrist at 0–20 degrees of extension, leaving the fingers free (Fig. 6). Brininger et al[40] have recently proposed immobilization of both the wrist and fingers at a neutral position (0 degree) and reported symptom improvement after 4 weeks of treatment. Indeed, the blockade of fingers reduces the repetitive intrusion of the intratunnel lumbrical, which may represent mechanical stress for the MN.

The authors suggest using the orthosis during the night hours to optimize its tolerance, prevent abnormal wrist positions, and promote the washout of inflammatory metabolites (Table 6). The effectiveness of night orthosis has also been demonstrated in patients with severe CTS[41]. Sim et al[42] have reported that a combination of wrist orthosis, therapeutic US, and neural mobilization exercises was not superior to wrist orthosis alone. Likewise, corticosteroid injections of the carpal tunnel seem more effective than night splint alone in CTS[43]. Interestingly, Figuereido et al[44] reported that the effects of customized versus commercial splints are similar in CTS.

As regards the timing, Gatheridge et al[45] suggested 6 weeks as the optimal duration of orthotic treatment in patients with moderate CTS (Table 6). Beyond 6 weeks, there seem to be no further improvements in the patient's symptoms. The effectiveness of wrist orthoses varied based on the underlying etiology of CTS. Idiopathic CTS patients showed the greatest benefit, with reported pain reductions of 30%–50% on the VAS scale and functional improvements of 20%–40% on the Boston Carpal Tunnel Questionnaire (BCTQ) after 4–6 weeks of night splinting.

For diabetes-related CTS, symptom relief was generally lower, with only 20%–30% improvement in pain and function, possibly due to pre-existing peripheral neuropathy and microvascular compromise affecting nerve regeneration. Similarly, patients with rheumatoid arthritis-related CTS experienced less pronounced benefits (15%–25% pain reduction) due to persistent joint inflammation and synovial hypertrophy, which limit the ability of splinting to reduce nerve compression.

Pregnancy-related CTS, which is often transient, responded well to splinting, with 50%–60% of patients experiencing complete symptom resolution by the end of pregnancy, suggesting that hormonal and fluid retention changes play a key role in symptom modulation. Post-traumatic CTS cases showed more

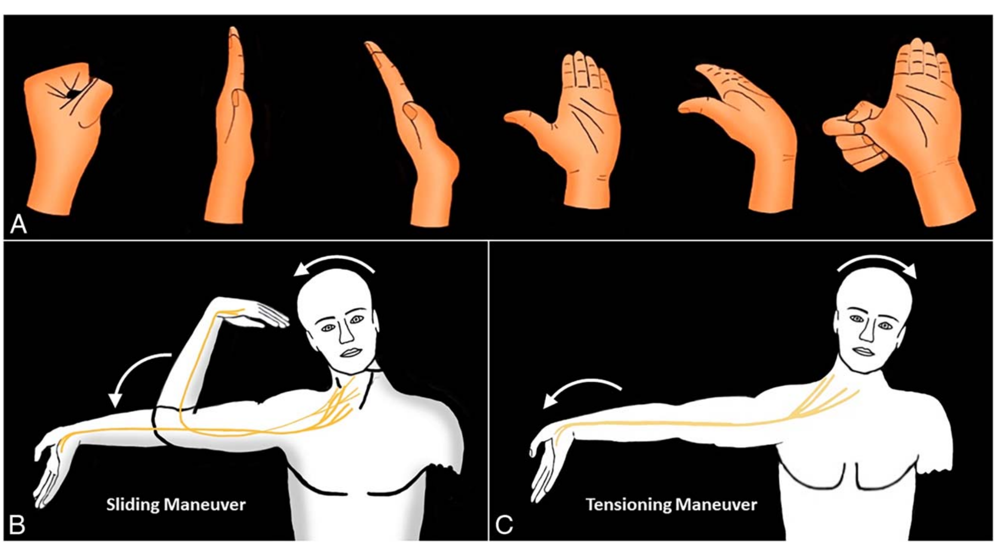

Figure 3. *Tendon gliding exercise positions*. The five standard positions—straight, hook, fist, tabletop, and straight fist—facilitate tendon excursion and reduce intra-tunnel pressure.

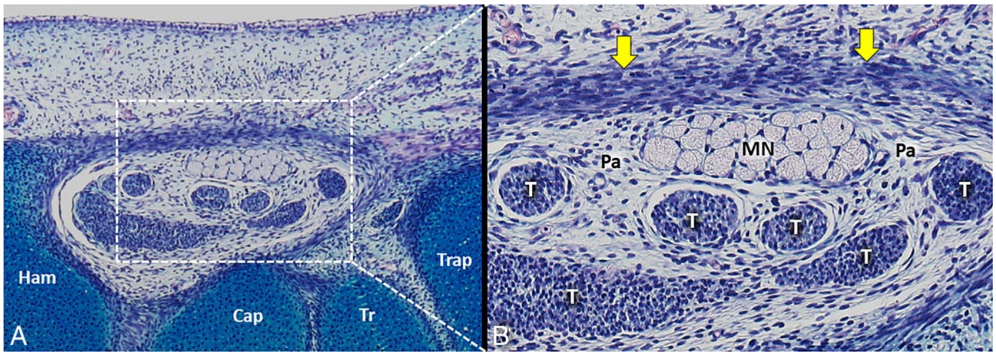

Figure 4. *Manual therapy technique for CTS*. Therapist-performed soft tissue mobilization is applied over the flexor retinaculum and adjacent tissues to reduce stiffness and improve circulation.

variable responses, with 25%–40% functional improvement, often requiring additional interventions such as manual therapy or injections.

These findings suggest that while wrist orthoses remain a first-line conservative treatment, their effectiveness is influenced by the underlying pathology, and tailored multimodal approaches may be necessary for certain patient populations.

Physical therapy

Extracorporeal shockwave therapy

Extracorporeal shockwave therapy (ESWT) promotes fluid drainage within the carpal tunnel, decreasing intraneural and perineural pressure. It also reduces the transverse carpal ligament and subsynovial tissue stiffness, improving the MN gliding[46]. Several authors have compared ESWT with other nonsurgical treatments, eg, injections and orthoses in CTS. A wide heterogenicity regarding the type of ESWT (radial vs. focal), machine settings (energy flux density, total energy, number of repetitions, etc.), and anatomical site of application (over the carpal tunnel vs. along the entire MN) is associated with conflicting results among different studies. For instance, Gesslbauer et al[46] reported that ESWT (vs. sham therapy) improved the MN neurophysiological parameters in CTS. Other authors reported that combining ESWT with night orthosis (vs. orthosis alone) did not change the clinical outcome[47,48]. Rashad et al[49] mentioned that ESWT was effective in treating CTS patients with different degrees of severity unless they had severe motor involvement.

Ultrasound

Biological effects of US therapy are thermal and mechanical. The former pertains to the increased perfusion of soft tissues, activation of local metabolic pathways, and washout of algogenic substances[50]. Drainage of fluids, release of local adhesions, and threshold modulations of nociceptors are, instead, the mechanical effects of US therapy[50]. Catalbas et al[40] published a randomized controlled trial demonstrating no differences in clinical, electrophysiological, and sonographic parameters with the use of continuous, pulsed, or sham US in addition to splinting. In a systematic review and meta-analysis, Peris Moya et al[51] reported that US therapy was better than placebo and mobilization in CTS. However, the authors did not evaluate machine technical settings or the duration of physical therapy. Chen et al[52] reported the superiority of US therapy applied with neural mobilization exercises when compared to manual therapy alone.

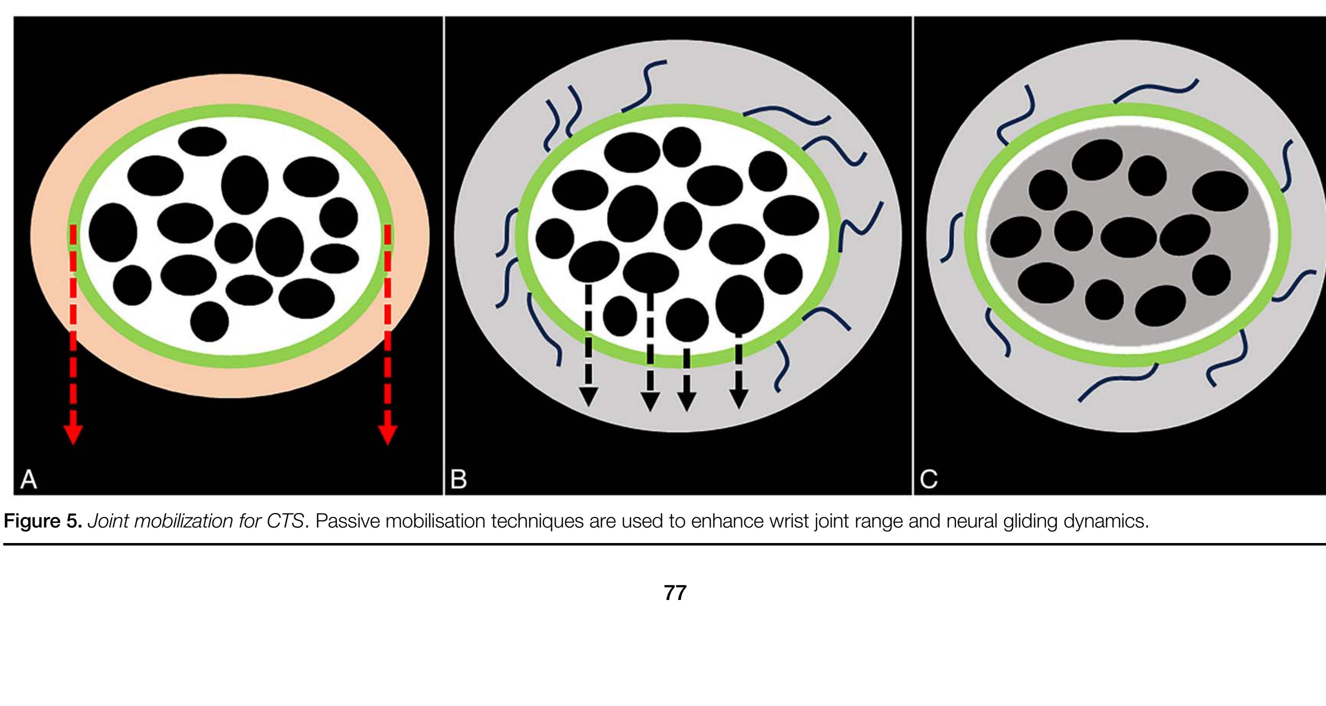

Figure 5. *Joint mobilization for CTS*. Passive mobilisation techniques are used to enhance wrist joint range and neural gliding dynamics.

Table 6

Orthoses for carpal tunnel syndrome.

Why	↑ carpal tunnel's inner volume by aligning the radiocarpal joint
	↓ prolonged postures in extreme extension or flexion of the wrist
	↓pressure within the carpal tunnel
Where	Radiocarpal joint
	Radiocarpal joint + fingers*
How	Neutral position of the radiocarpal joint (0 degree)
	Mild extended position of the radiocarpal joint (20 degrees of extension)
When	6 weeks (especially during the night hours)
Selection Criteria	Tolerability, esthetic, durability

*Fingers' block prevents the repetitive intrusion of lumbrical muscles inside the carpal tunnel.

Kinesiotaping

When applied with other conservative treatments, kinesiotaping reduces the CTS symptoms in the short term[53]; however, a standardized approach to performing this technique is not present in the literature[54]. In the author's experience, this technique can be applied at the volar aspect of the wrist and forearm with a tension below 50%. It activates the cutaneous sensory receptors, leading to neuromodulation of nociceptive inputs through the gate control mechanism at the spinal cord.

Laser therapy

Laser therapy promotes edema drainage, washout of inflammatory molecules, and modulation of nociceptors threshold causing pain reduction[55]. While Akgol et al[56] reported greater efficacy of laser therapy (vs. kinesiotaping) in CTS, Cheung et al[57] found no additional benefit compared with splinting.

Figure 6. *Example of a neutral wrist orthosis*. Designed to maintain the wrist in 0–20° extension, the orthosis reduces median nerve compression and improves nocturnal symptoms.

The reviewed studies reported significant variability in the duration, frequency, and number of sessions for different physical modalities. The most commonly used treatment protocols were the following:

- Extracorporeal shockwave therapy (ESWT): 1 session per week for 4–6 weeks
- Ultrasound therapy (US): 3–5 sessions per week for 4 weeks
- Low-level laser therapy (LLLT): daily or alternate-day sessions for 2–4 weeks
- Kinesiotaping: applied twice per week for 4 weeks

The effectiveness of these modalities varied depending on the underlying etiology of CTS. Idiopathic CTS showed the best response, with 30%–50% pain reduction and 20%–40% functional improvement across different physical therapies. Diabetes-related CTS exhibited lower response rates, particularly for ESWT and laser therapy, with 15%–30% symptom relief, likely due to the reduced neural repair capacity associated with diabetic neuropathy.

Patients with rheumatoid arthritis-related CTS demonstrated modest improvements (10%–25% pain reduction) with ultrasound and laser therapy, but persistent synovial inflammation often limited the overall functional recovery. In pregnancy-related CTS, ultrasound therapy and kinesiotaping provided 40%–60% symptom relief, suggesting a strong role in transient, fluid-retention-related nerve compression. Post-traumatic CTS, often associated with scar tissue and fibrosis, responded variably, with 20%–35% functional gains, particularly when ultrasound therapy was combined with manual therapy or neural mobilization.

These findings emphasize that while physical modalities can provide meaningful symptom relief, their effectiveness is highly dependent on the underlying etiology. Future studies should explore tailored protocols to optimize treatment strategies for different patient populations.

Discussion

Despite several nonsurgical approaches that have been described in the literature; to date, a standardized conservative management of this common painful/disabling condition is lacking. As such, this narrative review aimed to summarize the different conservative techniques to propose a practical guide to managing CTS patients in daily practice.

Injection of corticosteroids within the carpal tunnel is commonly performed, especially in the acute phase, to manage severe nocturnal neuropathic pain and paresthesias. They improve median edema at the entrapment site beneath the transverse carpal ligament[11,58]. Likewise, US-guided hydrodissection of the multiple histological interfaces between the MN and the surrounding soft tissues (eg, the transverse carpal ligament, the synovial sheath of the flexor tendons, and the subsynovial connective tissue) is performed in the chronic phase of CTS. High-volume D5W is used to release perineural adhesions and restore physiological neural gliding[13].

Manual therapies and neural mobilizations encompass an extremely variable cluster of different rehabilitation techniques. In the acute phase of CTS, the sliding techniques through oscillatory movements of the MN reduce the intraneural pressure, promote the drainage of fascicular edema, and enhance neural perfusion without the symptoms' exacerbation. Instead, tensioning techniques and tendon gliding exercises can be performed in the chronic phase of CTS to release perineural adhesions, counteract intraneural fibrosis, and restore MN gliding inside the carpal tunnel[23,29,33,34].

Wrist orthosis that positions the radiocarpal joint at 0–20 degrees of extension to increase the carpal tunnel inner volume is largely used, especially during the night, to avoid prolonged abnormal postures. Usually, splinting is combined with corticosteroid injection in the acute phase (first 4–6 wk) to rapidly reduce pain and paresthesias[37,38,59].

As regards physical therapy, conflicting pieces of evidence have been published in the scientific literature—due to extreme heterogeneity of the machine/equipment, technical settings, and protocols in terms of the number of treatments and session duration. Scientific interest is progressively mounting on the potential role of ESWT in the drainage of median nerve edema and reduction of the stiffness of soft tissues[40,46].

Considering the data available on the nonsurgical approaches to the CTS described above and the long-lasting authors' experience in hand rehabilitation, some clinical hints can be proposed to optimize the clinical management of these patients. In the acute phase, for prompt management of severe nocturnal pain and paresthesias, the combination of corticosteroid injection and wrist orthosis would be an effective approach. US guidance can be used to avoid iatrogenic injury, safely releasing the injectate inside the carpal tunnel. Likewise, in this phase, gentle oscillatory movements of the MN through sliding exercises may be given. Instead, in the chronic phase, US-guided hydrodissection of the MN from the surrounding soft tissues can be combined with tendon gliding exercises and neural tensioning techniques. This way, perineural adhesions can be treated, and neural gliding inside the carpal tunnel can be restored. Herein, the high-volume perineural injection can be considered a "boost" to maximize the mechanical effects of the rehabilitation exercises on neural/tendon gliding[60–62].

Critical comparison of injection therapies for carpal tunnel syndrome

Corticosteroid injections have long been considered the first-line treatment for mild to moderate CTS due to their rapid anti-inflammatory effects and short-term symptom relief. However, recent evidence suggests that 5% dextrose injections (D5W) and platelet-rich plasma (PRP) may offer alternative benefits, particularly in patients with chronic or recurrent CTS. The mechanisms of action differ significantly: corticosteroids primarily reduce local inflammation and edema, while D5W injections, often used in hydrodissection techniques, promote perineural adhesion release and improve nerve gliding. PRP, on the other hand, has been proposed for its regenerative potential, stimulating local tissue healing and reducing fibrotic changes in chronic CTS.

Several studies have compared these approaches. While corticosteroids provide fast symptom relief, their effects tend to diminish within 3–6 months, and repeated injections may pose a risk of tendon and nerve atrophy. D5W injections, conversely, appear to have a more prolonged benefit, possibly due to their role in modulating neurogenic inflammation and restoring perineural homeostasis. PRP injections, although promising in small trials, have shown inconsistent outcomes, likely due to variability in preparation methods and injection protocols. Future studies should aim to establish standardized guidelines for PRP use in CTS management.

From a clinical perspective, the choice between these injectables should be tailored based on disease severity and patient-specific factors. Corticosteroids may be preferable for acute symptom relief, particularly in patients with severe nocturnal pain, while D5W may be better suited for chronic cases requiring restoration of nerve mobility. PRP may be considered for patients with persistent symptoms who have not responded to conventional therapies, although further high-quality evidence is needed to support its widespread use.

To optimize the real-world applicability of nonsurgical CTS treatments, patient-centered outcomes such as quality of life (QoL), return-to-work rates, and long-term satisfaction must be emphasized. Many studies primarily focus on short-term symptom relief, while fewer investigate functional recovery in everyday activities. Studies indicate that multimodal approaches, particularly the combination of manual therapy, neurodynamic mobilization, and injections, show the greatest improvements in QoL metrics such as the Boston Carpal Tunnel Questionnaire (BCTQ) and DASH scores. Patients with idiopathic CTS report higher QoL improvements (30%–50%), whereas those with diabetes or rheumatoid arthritis-related CTS experience lower benefits (10%–25%) due to persistent systemic factors. Among working-age individuals (30–60 y), return-to-work success varies by treatment approach. Corticosteroid injections provide short-term relief, but relapses often require additional interventions. D5W injections and neurodynamic mobilization demonstrate higher return-to-work rates (~60%) due to long-term symptom control. Orthoses and extracorporeal shockwave therapy (ESWT) are particularly beneficial for patients in manual labor-intensive occupations, helping to reduce absenteeism. In terms of long-term satisfaction, treatments combining rehabilitation with injections tend to yield higher patient-reported satisfaction compared with monotherapy. Patients undergoing D5W injections combined with tendon gliding exercises report the highest long-term satisfaction (70%), particularly for chronic CTS cases.

Long-term outcomes and patient-centered metrics

Another critical aspect in nonsurgical CTS management is the long-term impact of different interventions. While most studies focus on short-term pain reduction and functional improvement, patient-centered metrics such as quality of life, satisfaction, and return to work are often underreported. Emerging evidence suggests that multimodal approaches—combining injections with rehabilitation strategies like neural mobilization and tendon gliding exercises—may lead to superior functional outcomes.

A comparative analysis of treatment efficacy across different etiologies of CTS reveals significant variations in response to conservative management. Idiopathic CTS showed the highest overall improvement across all modalities, with 30%–50% pain reduction and 20%–40% functional improvement, particularly in response to corticosteroid injections, neurodynamic mobilization, and ESWT. In contrast, diabetes-related CTS exhibited 15%–30% improvement, with reduced responsiveness to corticosteroids and ESWT, likely due to underlying peripheral neuropathy and impaired neural regeneration. Rheumatoid arthritis-related CTS had a lower response to all treatments (10%–25% improvement), especially for orthoses and manual therapy, as persistent synovial inflammation limited the efficacy of these interventions. Pregnancy-related CTS, being largely transient, responded well to conservative treatments, with 40%–60% improvement, particularly with ultrasound therapy and kinesiotaping. Post-traumatic CTS showed moderate and variable responses (20%–35% improvement), with a stronger effect observed when ultrasound therapy and neural mobilization were combined.

Regarding age-related differences, younger patients (< 50 y) showed greater improvement with manual therapy, neurodynamic mobilization, and kinesiotaping, suggesting a better adaptive capacity of the nervous system and connective tissues. In contrast, older patients (> 60 y) responded better to corticosteroid injections and orthoses, likely due to a reduced ability to benefit from neurodynamic rehabilitation and tissue mobilization. Patients aged 50–60 years exhibited intermediate responses, with multimodal approaches combining injections, rehabilitation, and physical modalities yielding the best results.

These findings suggest that treatment selection should be tailored based on both the underlying etiology and patient age group. Future studies should focus on personalized rehabilitation strategies, integrating multimodal approaches with etiology-specific and age-specific adaptations to optimize outcomes.

Future research should prioritize the development of standardized treatment protocols that integrate various conservative therapies, encouraging multicenter studies to validate findings and support personalized care strategies[63]. In addition, investigating the role of combination therapies, such as corticosteroid injections followed by D5W hydrodissection or ESWT, may help refine conservative treatment pathways for CTS.

CRediT author statement

D.D. and V.R. conceptualized and designed the study and were responsible for data acquisition. B.V. and L.T. drafted the manuscript. P.B., R.T. and O.L. provided supervision and guidance throughout the study. N.A. performed the editing of the manuscript. P.L. and P.B. reviewed the manuscript and curated the methodology. All authors have read and agreed to the published version of the manuscript.

Declaration of competing interest

The authors declare that they have no financial conflict of interest with regard to the content of this report.

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Ethics statement

Written permission was obtained from the patients.

Data availability statement

The dataset is available upon request from the authors.

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Declaration of generative AI and AI-assisted technologies in the writing process

The authors confirm that no Artificial Intelligence (AI)-Assisted technology was used to assist in the writing or editing of the manuscript, and no images were manipulated using AI.

References

[1] Osiak K, Elnazir P, Walocha JA, *et al.* Carpal tunnel syndrome: state-of-the-art review. Folia Morphol (Warsz) 2022;81:851–62.
[2] Padua L, Cuccagna C, Giovannini S, *et al.* Carpal tunnel syndrome: updated evidence and new questions. Lancet Neurol 2023;22:255–67.
[3] Robben E, Dever J, De Groef A, *et al.* Subsynovial connective tissue thickness in carpal tunnel syndrome: a systematic review. Clin Biomech (Bristol) 2020;75:105002.
[4] Mezian K, Ricci V, Güvener O, *et al.* EURO-MUSCULUS/USPRM dynamic ultrasound protocols for wrist andhand. Am J Phys Med Rehabil 2022;101:e132–8.
[5] Padua L, Coraci D, Erra C, *et al.* Carpal tunnel syndrome: clinical features, diagnosis, and management. Lancet Neurol 2016;15:1273–84.
[6] Godoi J, Kerppers II, Rossi LP, *et al.* Electromyographic analysis of biceps brachii muscle following neural mobilization in patients with stroke. Electromyogr Clin Neurophysiol 2010;50:55–60.
[7] Ricci V, Özçakar L. Life after ultrasound: are we speaking the same (or a new) language in Physical and Rehabilitation Medicine? J Rehabil Med 2019;51:234–5.
[8] Lin TY, Chang KV, Wu WT, *et al.* Ultrasonography for the diagnosis of carpal tunnel syndrome: an umbrella review. J Neurol 2022;269: 4663–75.
[9] Chen IJ, Chang KV, Lou YM, *et al.* Can ultrasound imaging be used for the diagnosis of carpal tunnel syndrome in diabetic patients? A systemic review and network meta-analysis. J Neurol 2020;267:1887–95.
[10] Milone MT, Karim A, Klifto CS, *et al.* Analysis of expected costs of carpal tunnel syndrome treatment strategies. Hand (N Y) 2019;14:317–23.
[11] Marshall S, Tardif G, Ashworth N. Local corticosteroid injection for carpal tunnel syndrome. Cochrane Database Syst Rev 2007;2:CD001554.
[12] Dong C, Sun Y, Qi Y, *et al.* Effect of platelet-rich plasma injection on mild or moderate carpal tunnel syndrome: an updated systematic review and meta-analysis of randomized controlled trials. Biomed Res Int 2020; 2020:5089378.
[13] Bahrami MH, Raeissadat SA, Nezamabadi M, *et al.* Interesting effectiveness of ozone injection for carpal tunnel syndrome treatment: a randomized controlled trial. Orthop Res Rev 2019;11:61–7.
[14] Raeissadat SA, Karimzadeh A, Hashemi M, *et al.* Safety and efficacy of platelet-rich plasma in treatment of carpal tunnel syndrome; a randomized controlled trial. BMC Musculoskelet Disord 2018;19:49.

[15] Mathieu T, Lemmens E, Stassijns G. A safe and easy-to-use ultrasound-guided hydrodissection technique for the carpal tunnel syndrome: a minimally invasive approach. J Ultrasound 2022;25:451–5.
[16] Babaei-Ghazani A, Roomizadeh P, Forogh B, *et al.* Ultrasound-guided versus landmark-guided local corticosteroid injection for carpal tunnel syndrome: a systematic review and meta-analysis of randomized controlled trials. Arch Phys Med Rehabil 2018;99:766–75.
[17] Rayegani SM, Raeissadat SA, Ahmadi-Dastgerdi M, *et al.* Comparing the efficacy of local triamcinolone injection in carpal tunnel syndrome using three different approaches with or without ultrasound guidance. J Pain Res 2019;12:2951–8.
[18] Zaheer SA, Ahmed Z. Neurodynamic techniques in the treatment of mild-to-moderate carpal tunnel syndrome: a systematic review and meta-analysis. J Clin Med 2023;12:4888.
[19] Fernández-de-Las-Peñas C, Cleland J, Palacios-Ceña M, *et al.* The effectiveness of manual therapy versus surgery on self-reported function, cervical range of motion, and pinch grip force in carpal tunnel syndrome: a randomized clinical trial. J Orthop Sports Phys Ther 2017;47:151–61.
[20] Rushton A, Carlesso LC, Flynn T, *et al.* International framework for examination of the cervical region for potential of vascular pathologies of the neck prior to musculoskeletal intervention: International IFOMPT Cervical Framework. J Orthop Sports Phys Ther 2023;53:7–22.
[21] Donati D, Boccolari P, Tedeschi R. Manual therapy vs. surgery: which is best for carpal tunnel syndrome relief? Life (Basel) 2024;14:1286.
[22] Tedeschi R, Platano D, Melotto G, *et al.* Effectiveness of neurodynamic treatment in managing lateral epicondylitis: a systematic review. Manuelle Medizin. 2024;62:276–83.
[23] Horng YS, Hsieh SF, Tu YK, *et al.* The comparative effectiveness of tendon and nerve gliding exercises in patients with carpal tunnel syndrome: a randomized trial. Am J Phys Med Rehabil 2011;90:435–42.
[24] Lanfranchi E, Vandelli S, Boccolari P, *et al.* Efficacy and patient acceptability of 3 orthosis models for radial nerve palsy. Hand Surg Rehabil. 2024;43:101677.
[25] Santandrea S, Benassi M, Tedeschi R. Comparison of short-stretch bandage and long-stretch bandage for post-traumatic hand edema. Int J Surg Case Rep 2023;111:108854.
[26] Boccolari P, Tedeschi R, Donati D. Breaking stiffness: a non-invasive solution for proximal interphalangeal joint rigidity. Hand Surg Rehabil. 2025;44:102096.
[27] Tedeschi R, Platano D, Melotto G, *et al.* Effectiveness of manual thoracic therapy in treating impingement syndrome: a systematic review. Manuelle Medizin. 62:178–86.
[28] Keser I, Kirdi N, Meric A, *et al.* Comparing routine neurorehabilitation program with trunk exercises based on Bobath concept in multiple sclerosis: pilot study. J Rehabil Res Dev 2013;50:133–40.
[29] Ellis R, Carta G, Andrade RJ, *et al.* Neurodynamics: is tension contentious? J Man Manip Ther 2022;30:3–12.
[30] Schmid AB, Coppieters MW, Ruitenberg MJ, *et al.* Local and remote immune-mediated inflammation after mild peripheral nerve compression in rats. J Neuropathol Exp Neurol 2013;72:662–80.
[31] Wolny T, Linek P. Long-term patient observation after conservative treatment of carpal tunnel syndrome: a summary of two randomised controlled trials. PeerJ 2019;7:e8012.
[32] Wolny T, Linek P. Is manual therapy based on neurodynamic techniques effective in the treatment of carpal tunnel syndrome? A randomized controlled trial. Clin Rehabil 2019;33:408–17.
[33] Wolny T, Linek P. Neurodynamic techniques versus "sham" therapy in the treatment of carpal tunnel syndrome: a randomized placebo-controlled trial. Arch Phys Med Rehabil 2018;99:843–54.
[34] Millesi H, Zöch G, Reihsner R. Mechanical properties of peripheral nerves. Clin Orthop Relat Res 1995;314:76–83.
[35] Wiberg A, Pawa A, Quick TJ. Paraneurium—a veiled threat to peripheral nerve function. J Plast Reconstr Aesthet Surg 2024;90:183–5.
[36] Osamura N, Zhao C, Zobitz ME, *et al.* Evaluation of the material properties of the subsynovial connective tissue in carpal tunnel syndrome. Clin Biomech (Bristol, Avon) 2007;22:999–1003.
[37] Ibrahim I, Khan WS, Goddard N, *et al.* Carpal tunnel syndrome: a review of the recent literature. Open Orthop J 2012;6:69–76.
[38] Halac G, Demir S, Yucel H, *et al.* Splinting is effective for night-only symptomatic carpal tunnel syndrome patients. J Phys Ther Sci 2015;27: 993–6.
[39] Brininger TL, Rogers JC, Holm MB, *et al.* Efficacy of a fabricated customized splint and tendon and nerve gliding exercises for the treatment of carpal tunnel syndrome: a randomized controlled trial. Arch Phys Med Rehabil 2007;88:1429–35.
[40] Çatalbaş N, Akkaya N, Atalay NS, *et al.* Ultrasonographic imaging of the effects of continuous, pulsed or sham ultrasound treatments on carpal tunnel syndrome: a randomized controlled study. J Back Musculoskelet Rehabil 2018;31:981–9.
[41] Karjalainen TV, Lusa V, Page MJ, *et al.* Splinting for carpal tunnel syndrome. Cochrane Database Syst Rev 2023;2:CD010003.
[42] Sim SE, Gunasagaran J, Goh KJ, *et al.* Short-term clinical outcome of orthosis alone vs combination of orthosis, nerve, and tendon gliding exercises and ultrasound therapy for treatment of carpal tunnel syndrome. J Hand Ther 2019;32:411–6.
[43] de Moraes VY, Queiroz J, Raduan-Neto J, *et al.* Nonsurgical treatment for symptomatic carpal tunnel syndrome: a randomized clinical trial comparing local corticosteroid injection versus night orthosis. J Hand Surg Am 2021;46:295–300.e1.
[44] Figueiredo DS, Ciol MA, da Conceição Dos Santos M, *et al.* Comparison of the effect of nocturnal use of commercial versus custom-made wrist orthoses, in addition to gliding exercises, in the function and symptoms of carpal tunnel syndrome: a pilot randomized trial. Musculoskelet Sci Pract 2020;45:102089.
[45] Gatheridge MA, Sholty EA, Inman A, *et al.* Splinting in carpal tunnel syndrome: the optimal duration. Mil Med 2020;185:e2049–54.
[46] Gesslbauer C, Mickel M, Schuhfried O, *et al.* Effectiveness of focused extracorporeal shock wave therapy in the treatment of carpal tunnel syndrome: a randomized, placebo-controlled pilot study. Wien Klin Wochenschr 2021;133:568–77.
[47] Koçak Ulucaköy R, Yurdakul FG, Bodur H. Extracorporeal shock wave therapy as a conservative treatment option for carpal tunnel syndrome: a double-blind, prospective, randomized, placebo-controlled study. Turk J Phys Med Rehabil 2020;66:388–97. doi:10.5606/tftrd.2020.3956
[48] Chen YP, Lin CY, Kuo YJ, *et al.* Extracorporeal shockwave therapy in the treatment of trigger finger: a randomized controlled study. Arch Phys Med Rehabil 2021;102:2083–90.e1.
[49] Rashad UM, Kishk NA, Mansour WT, *et al.* Effect of extracorporeal shock wave therapy on different severities of carpal tunnel syndrome. Egypt. J. Neurol. Psychiatry Neurosurg 2020;56:48.
[50] Page MJ, O'Connor D, Pitt V, *et al.* Therapeutic ultrasound for carpal tunnel syndrome. Cochrane Database Syst Rev 2013;2013:CD009601.
[51] Peris Moya A, Pérez Mármol JM, Khoury Martín EF, *et al.* Ultrasound improves motor distal latency on patients with carpal tunnel syndrome: systematic review and meta-analysis. Eur J Phys Rehabil Med 2022;58: 206–17.
[52] Chen S, Qian Y, Sun Z, *et al.* Effectiveness of therapeutic ultrasound for the treatment of carpal tunnel syndrome (the USTINCTS trial): study protocol for a three-arm, prospective, multicentre, randomised controlled trial. BMJ Open 2022;12:e057541.
[53] Güvener O, Dağ F, Şahin G, *et al.* Immediate effects of Kinesio taping in carpal tunnel syndrome: a randomized controlled double-blind ultrasonographic study. J Hand Ther 2024;37:520–8.
[54] Tomás-Escolar A, Merino-Andrés J, Sánchez-Sierra A, *et al.* Short-term effectiveness of kinesio taping as therapeutic tool in conservative treatment of carpal tunnel syndrome: a systematic review and meta-analysis. Physiother Res Int 2023:e2026. doi: 10.1002/pri.2026.
[55] Rankin IA, Sargeant H, Rehman H, *et al.* Low-level laser therapy for carpal tunnel syndrome. Cochrane Database Syst Rev 2017;8:CD012765. doi:10.1002/14651858.CD012765
[56] Akgol G, Elbasti MS, Gulkesen A, *et al.* Comparison of low power laser and kinesio taping for the treatment of carpal tunnel syndrome: a prospective randomized study. J Back Musculoskelet Rehabil 2021;34: 545–53.
[57] Cheung WKW, Wu IXY, Sit RWS, *et al.* Low-level laser therapy for carpal tunnel syndrome: systematic review and network meta-analysis. Physiotherapy 2020;106:24–35.
[58] Ashworth NL, Bland JDP, Chapman KM, *et al.* Local corticosteroid injection versus placebo for carpal tunnel syndrome. Cochrane Database Syst Rev 2023;2:CD015148.
[59] Ozgen M, Güngen G, Sarsan A, *et al.* Determination of the position on which the median nerve compression is at the lowest in carpal tunnel syndrome and clinical effectiveness of custom splint application. Rheumatol Int 2011;31:1031–6.
[60] Hobson-Webb LD, Padua L. Median nerve ultrasonography in carpal tunnel syndrome: findings from two laboratories. Muscle Nerve 2009;40: 94–7.

[61] Beddaa H, Kably B, Marzouk B, *et al*. The effectiveness of the median nerve neurodynamic mobilisation techniques in women with mild or moderate bilateral carpal tunnel syndrome: A single-blind clinical randomised trial. S Afr J Physiother 2022;78:1823.
[62] Chesterton LS, Blagojevic-Bucknall M, Burton C, *et al*. The clinical and cost-effectiveness of corticosteroid injection versus night splints for carpal tunnel syndrome (INSTINCTS trial): an open-label, parallel group, randomised controlled trial. Lancet 2018;392:1423–33.
[63] Lazovic M, Kocic M, Hrkovic M, *et al*. Effectiveness of combined ultrasound and exercise therapy in the treatment of carpal tunnel syndrome—randomized, placebo-controlled investigation. Srp Arh Celok Lek 2018;146:561–6.