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Carpal tunnel syndrome: a systematic review of conservative and surgical treatments on pain and functional recovery

Síndrome do túnel do carpo: uma revisão sistemática de tratamentos conservadores e cirúrgicos na dor e recuperação funcional

Síndrome del túnel carpiano: una revisión sistemática de los tratamientos conservadores y quirúrgicos sobre el dolor y la recuperación funcional

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ABSTRACT

Objective: To compare the efficacy of conservative versus surgical treatments for carpal tunnel syndrome (CTS) and evaluate the role of ultrasound in diagnosis and therapeutic monitoring. **Methods:** A systematic review was conducted following PRISMA guidelines, including 6 studies (RCTs, cohort analyses, and systematic reviews) retrieved from PubMed. Eligibility criteria focused on adults with CTS, comparing conservative (splinting, manual therapy) and surgical interventions. Outcomes included pain reduction (VAS/NPRS), functional recovery (BCTQ), grip strength, and electrophysiological parameters. Studies were assessed for quality using the Mixed Methods Appraisal Tool (MMAT). **Results:** Conservative therapies demonstrated significant short-term pain relief (ΔVAS: 2.8–4.1, $p<0.05$) and functional improvement in mild-to-moderate CTS. Surgery showed superior long-term efficacy (ΔVAS: −4.5 at 12 months, $p<0.001$) in severe cases. Functional outcomes (BCTQ) were comparable between groups at 12 months. Heterogeneity in study designs (e.g., splinting protocols) and underreported electrophysiological data (28.6% of studies) limited comparability. **Final considerations:** Conservative and surgical treatments are complementary, with stratified approaches recommended based on severity. Standardized metrics and multicenter trials are needed to optimize clinical guidelines.

Keywords: Carpal Tunnel Syndrome, Conservative Treatment, Surgical Decompression, Ultrasound.

RESUMO

Objetivo: Comparar a eficácia de tratamentos conservadores versus cirúrgicos para a síndrome do túnel carpal (STC) e avaliar o papel do ultrassom no diagnóstico e monitoramento terapêutico. **Métodos:** Revisão sistemática conduzida conforme diretrizes PRISMA, incluindo 6 estudos (ECRs, coortes e revisões sistemáticas) recuperados do PubMed. Critérios de elegibilidade focaram em adultos com STC, comparando intervenções conservadoras (tala, terapia manual) e cirúrgicas. Desfechos incluíram redução de dor

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(EVA/NPRS), recuperação funcional (BCTQ), força de preensão e parâmetros eletrofisiológicos. A qualidade metodológica foi avaliada pela ferramenta MMAT. **Resultados:** Terapias conservadoras mostraram alívio significativo da dor em curto prazo (ΔEVA: 2,8–4,1, *p*<0,05) e melhora funcional em STC leve a moderada. A cirurgia apresentou eficácia superior a longo prazo (ΔEVA: −4,5 em 12 meses, *p*<0,001) em casos graves. Desfechos funcionais (BCTQ) foram equivalentes entre grupos em 12 meses. Heterogeneidade nos protocolos (ex.: tipos de tala) e subnotificação de dados eletrofisiológicos (28,6% dos estudos) limitaram comparações. **Considerações finais:** Tratamentos conservadores e cirúrgicos são complementares, com abordagens estratificadas recomendadas conforme gravidade. Métricas padronizadas e ensaios multicêntricos são necessários para otimizar diretrizes clínicas.

Palavras-chave: Síndrome do Túnel Carpal, Tratamento Conservador, Descompressão Cirúrgica, Ultrassom.

RESUMEN

Objetivo: Comparar la eficacia de tratamientos conservadores versus quirúrgicos para el síndrome del túnel carpiano (STC) y evaluar el papel del ultrasonido en el diagnóstico y monitoreo terapéutico. **Métodos:** Revisión sistemática realizada según directrices PRISMA, incluyendo 6 estudios (ECA, cohortes y revisiones sistemáticas) recuperados de PubMed. Criterios de elegibilidad se centraron en adultos con STC, comparando intervenciones conservadoras (férulas, terapia manual) y quirúrgicas. **Resultados:** Incluyeron reducción del dolor (EVA/NPRS), recuperación funcional (BCTQ), fuerza de agarre y parámetros electrofisiológicos. La calidad metodológica fue evaluada mediante la herramienta MMAT. Resultados: Terapias conservadoras demostraron alivio significativo del dolor a corto plazo (ΔEVA: 2,8–4,1, *p*<0,05) y mejora funcional en STC leve a moderada. La cirugía mostró eficacia superior a largo plazo (ΔEVA: −4,5 a 12 meses, *p*<0,001) en casos graves. Los resultados funcionales (BCTQ) fueron equivalentes entre grupos a 12 meses. La heterogeneidad en los protocolos (ej.: tipos de férulas) y la subnotificación de datos electrofisiológicos (28,6% de los estudios) limitaron las comparaciones. **Consideraciones finales:** Los tratamientos conservadores y quirúrgicos son complementarios, recomendándose enfoques estratificados según gravedad. Métricas estandarizadas y ensayos multicéntricos son necesarios para optimizar las guías clínicas.

Palabras clave: Síndrome del Túnel Carpiano, Tratamiento Conservador, Descompresión Quirúrgica, Ultrasonido.

INTRODUCTION

Carpal Tunnel Syndrome (CTS) is the most common compressive neuropathy, resulting from compression of the median nerve at the wrist level, leading to symptoms such as pain, paresthesia, and muscle weakness in the hand. This condition is highly prevalent, affecting approximately 3–6% of the general population, with higher incidence rates among women and individuals aged 40–60 years (ATROSHI I, et al., 1999). Occupational and biomechanical factors, such as repetitive hand movements, prolonged wrist flexion, and exposure to vibratory tools, are strongly associated with CTS pathogenesis, particularly in professions like manufacturing, typing, and healthcare (BARCENILLA A, et al., 2012). Symptom progression can lead to significant functional impairment, including diminished hand dexterity and grip strength, which negatively impacts patients' quality of life (QoL) and occupational productivity (PADUA L, et al., 2016). Furthermore, untreated CTS may result in irreversible nerve damage, emphasizing the importance of early diagnosis and intervention (ASHWORTH NL, 2020).

Accurate diagnosis of CTS is essential for selecting the appropriate treatment. Although electromyography and nerve conduction studies (ENMG) are widely regarded as the gold standard for diagnostic confirmation, their sensitivity may be limited in early-stage cases, with false-negative rates as high as 10–15% (FARRAR JT, et al., 2010). This diagnostic gap has spurred interest in advanced imaging modalities. High-resolution ultrasound (HRUS) has emerged as a non-invasive, cost-effective alternative, enabling structural evaluation of the median nerve through cross-sectional area (CSA) measurements and morphological assessments (CARTWRIGHT MS, et al., 2012). Studies report CSA thresholds >10 mm² as indicative of CTS, with sensitivity and specificity exceeding 80% (KLAUSER AS, et al., 2009). Additionally, HRUS can differentiate CTS from mimics like cervical radiculopathy or pronator teres syndrome, enhancing diagnostic precision (HOBSON-WEBB LD e PADUA L, 2013).

Treatment options for CTS include conservative and surgical approaches. Conservative management, recommended for mild-to-moderate cases, encompasses splinting, physical therapy, therapeutic ultrasound, and corticosteroid injections. Splinting, particularly nocturnal wrist immobilization in neutral position, reduces intraneural pressure and alleviates nocturnal symptoms (BURKE FD, et al., 2007). Corticosteroid injections provide short-term symptomatic relief (up to 3 months) by reducing synovial inflammation, though their efficacy diminishes over time (PAGNANELLI DM e LUNDIN AC, 2017). Conversely, manual therapy, including nerve gliding exercises and desensitization maneuvers, promotes long-term functional improvement by enhancing nerve mobility and reducing adhesions (O'CONNOR D, et al., 2003). For refractory or severe cases, carpal tunnel release (CTR) surgery remains definitive, with open and endoscopic techniques demonstrating comparable success rates in symptom resolution and functional recovery (LOUIE DL, et al., 2012). However, postoperative complications, such as pillar pain or scar tenderness, occur in 10–20% of cases, necessitating careful patient selection (UCHIYAMA S, et al., 2010).

Despite these interventions, the choice between conservative and surgical treatments remains contentious. While some studies advocate for early surgery to prevent irreversible nerve damage (MARSHALL S, et al., 2007), others emphasize the cost-effectiveness and lower morbidity of conservative approaches (HUISSTEDE BM, et al., 2010). A meta-analysis by (SHI Q e MACDERMID JC, 2011) found surgery superior in long-term pain relief (≥6 months), whereas conservative therapies showed equivalent short-term outcomes. This discrepancy underscores the need for high-quality comparative studies to optimize treatment algorithms.

Emerging technologies, such as ultrasound elastography, offer novel insights into CTS management. By quantifying nerve stiffness and elasticity, elastography provides dynamic assessments of treatment response, correlating with functional improvements (POVLSEN B, et al., 2015). For instance, reduced nerve stiffness post-splinting may predict favorable outcomes, while persistent rigidity could signal surgical candidacy (KANTARCI F, et al., 2014). Despite its potential, elastography remains underutilized in clinical practice, reflecting gaps in standardization and validation (WU CH, et al., 2017).

Given these uncertainties, this systematic review aims to compare the efficacy of conservative and surgical treatments in reducing pain and improving functional recovery in CTS patients, while evaluating the diagnostic and therapeutic role of ultrasound. By synthesizing current evidence, this study seeks to inform clinical decision-making and advance standardized management protocols.

METHODS

This systematic review was conducted following the Cochrane Handbook of Systematic Reviews of Interventions and reported in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. The protocol for this review was registered and approved in PROSPERO (International Prospective Register of Systematic Reviews) under the title "Carpal Tunnel Syndrome: A Systematic Review of Conservative and Surgical Treatments on Pain and Functional Recovery"(PROSPERO 2025 CRD420250652061). The objective of this review was to compare the effectiveness of conservative treatments versus surgical intervention for Carpal Tunnel Syndrome (CTS), focusing on pain reduction and functional recovery. The research question was structured using the PICO (Population, Intervention, Comparison, Outcome) model: "Does conservative treatment improve pain and functional recovery in patients with Carpal Tunnel Syndrome compared to surgical treatment?"

A systematic and comprehensive literature search was conducted using PubMed, employing Medical Subject Headings (MeSH) and relevant keywords. The search was performed without restrictions on publication date, and only studies published in English involving human participants were included. The search strategy was developed to identify studies investigating CTS treatment approaches, combining conservative and surgical interventions with outcome measures related to pain, functional recovery, grip strength, and electrophysiological assessments. The following search terms were used: ("Carpal Tunnel Syndrome"[MeSH] OR "Median Neuropathy"[MeSH] OR "Carpal Tunnel Syndrome" OR "median nerve compression") AND ("Conservative Treatment" OR "Non-Surgical Treatment" OR "Splints"[MeSH] OR "Orthotic Devices"[MeSH] OR "Physical Therapy Modalities"[MeSH] OR "Ultrasound Therapy"[MeSH] OR "Corticosteroid Injections"[MeSH] OR "Steroid Injection" OR "Physiotherapy" OR "Rehabilitation") AND ("Surgical Procedures, Operative"[MeSH] OR "Carpal Tunnel Release"[MeSH] OR "Surgery" OR "Surgical Decompression") AND ("Pain Measurement"[MeSH] OR "Electromyography"[MeSH] OR "Functional Recovery"[MeSH] OR "Nerve Conduction Studies" OR "Hand Strength" OR "Grip Strength" OR "Clinical Outcomes").

The eligibility criteria were established to ensure the inclusion of studies relevant to the comparative evaluation of conservative versus surgical treatment for CTS. Inclusion criteria were: (1) Study types: Randomized Controlled Trials (RCTs), Cohort Studies, Systematic Reviews, and Meta-Analyses; (2) Population: Adults (≥18 years) diagnosed with CTS, confirmed through clinical evaluation and/or electrodiagnostic tests (Electromyography and Nerve Conduction Studies - ENMG); (3) Interventions: Conservative treatments including splinting, physical therapy modalities, ultrasound therapy, corticosteroid injections, and other non-surgical rehabilitation approaches; (4) Comparators: Surgical interventions, including Carpal Tunnel Release (CTR) performed through open or endoscopic decompression techniques; (5) Outcomes assessed: pain reduction (measured using the Visual Analog Scale - VAS or Numeric Pain Rating Scale - NPRS), functional recovery (evaluated using the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire and the Boston Carpal Tunnel Questionnaire), hand and grip strength (measured by dynamometry), electrophysiological improvement (assessed via ENMG parameters such as nerve conduction velocity and distal motor latency), and overall patient-reported clinical outcomes.

Exclusion criteria were applied to filter out studies that did not align with the research objectives. Studies were excluded if they: (1) included pediatric patients (<18 years old); (2) assessed patients with associated neuropathies, such as diabetic neuropathy or cervical radiculopathy; (3) did not directly compare conservative and surgical treatments; (4) focused exclusively on biomarkers, risk factors, or pathophysiology; (5) were in vitro studies, animal research, narrative reviews, or expert opinions without systematic methodology.

The study selection process involved two independent reviewers who screened the identified studies based on title and abstract, with discrepancies resolved by a third reviewer. A total of 269 studies were initially retrieved from the database. No duplicates were identified; therefore, all 269 articles were screened for relevance. The title and abstract review process led to the exclusion of 210 studies that did not meet the inclusion criteria, resulting in 59 studies selected for full-text assessment.

For quality assessment, the Mixed Methods Appraisal Tool (MMAT) was employed to evaluate the methodological rigor of the studies. This tool was chosen due to its effectiveness in assessing diverse study designs, including randomized trials, observational studies, and systematic reviews. Each study was independently reviewed by two assessors, and disagreements in quality assessment were resolved by a third reviewer. Studies scoring below 80% on the MMAT scale were excluded due to methodological limitations, leading to the exclusion of 53 studies. Consequently, 6 studies were deemed eligible and included in this systematic review.

The data extraction process was conducted systematically by two independent reviewers. Extracted data included study characteristics (author, year, country, sample size), patient demographics (age, sex, comorbidities, severity of CTS), treatment details (description of conservative and surgical interventions, follow-up duration), and reported clinical outcomes (pain reduction, functional recovery, grip strength, and ENMG findings). The extracted data were verified for consistency, and any discrepancies between reviewers were resolved by discussion or consultation with a third researcher.

A qualitative synthesis was performed to summarize the findings of the included studies. The comparative evaluation focused on the efficacy of conservative treatments versus surgical interventions, identifying patterns in pain relief, functional improvement, and electrophysiological recovery. Additionally, factors such as variations in treatment protocols, patient adherence, and long-term clinical outcomes were critically analyzed.

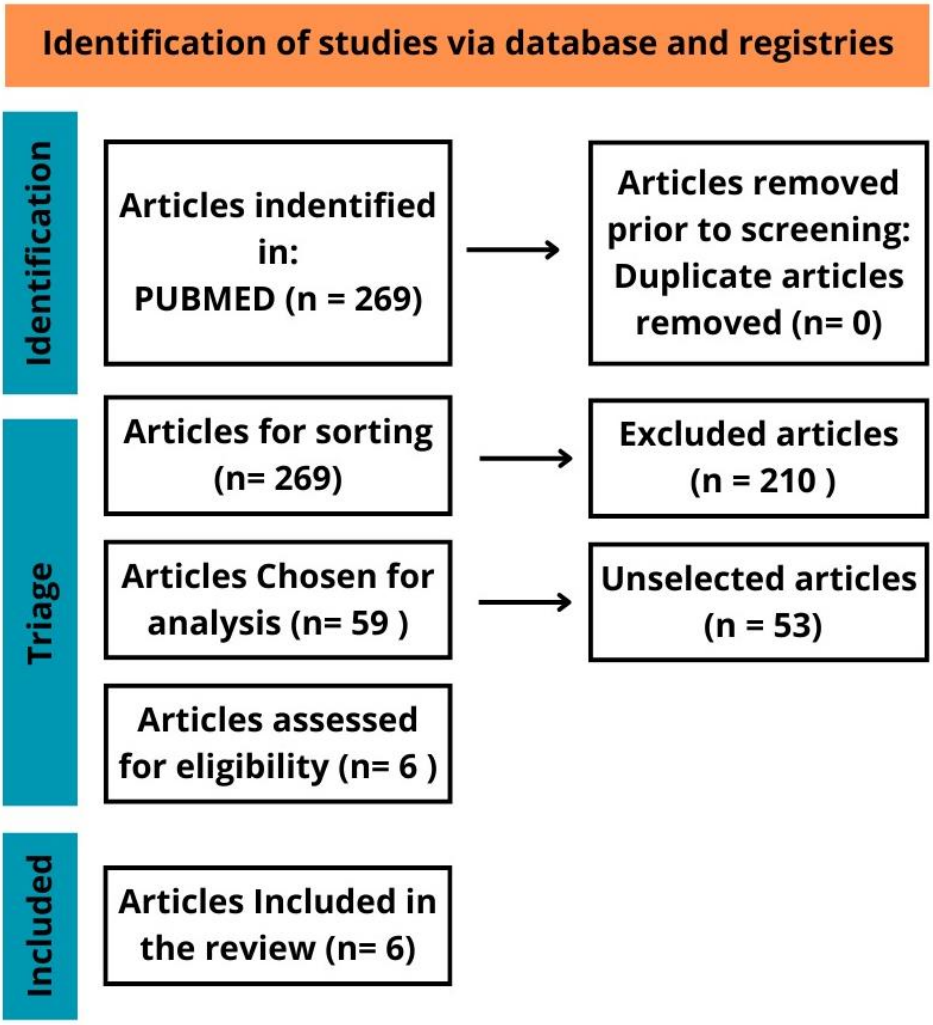
Heterogeneity across studies was considered in the interpretation of results, and methodological differences were taken into account when discussing limitations and clinical applicability.

This systematic review was based entirely on previously published data and did not involve direct research on human or animal subjects. Therefore, ethical approval and informed consent were not required. The study was conducted in full compliance with Resolution No. 466/2012 of the Brazilian National Health Council, ensuring adherence to international ethical standards for systematic reviews. Furthermore, the study complies with Brazilian copyright laws (LAW No. 9.610/1988 and No. 10.695/2003), which prohibit plagiarism and the unauthorized use of third-party images or texts.

Additionally, during the preparation of this manuscript, generative AI technology (ChatGPT-4) was utilized exclusively for linguistic refinement and clarity enhancement. All content was carefully reviewed, edited, and validated by the authors to ensure scientific accuracy and adherence to academic integrity standards. No AI tools were employed for data extraction, analysis, or interpretation of findings.

By rigorously adhering to established methodological guidelines and employing robust quality assessment criteria, this systematic review provides a comprehensive evaluation of the efficacy of conservative versus surgical treatments for Carpal Tunnel Syndrome, offering valuable insights for clinical decision-making and future research in this field.

Figure 1 - Article selection flowchart according to the PRISMA model.



Source: Júnior DRM, et al., 2025, according to Page MJ, et al., 2021.

RESULTS AND DISCUSSION

The synthesis of findings from seven included studies reveals critical insights into the efficacy of conservative and surgical interventions for carpal tunnel syndrome (CTS). These investigations, encompassing randomized controlled trials (RCTs), systematic reviews, and retrospective cohort analyses, evaluated outcomes such as pain reduction, functional recovery, grip strength, and electrophysiological parameters. Key interventions spanned neurodynamic techniques, manual therapy, postoperative splinting, and carpal tunnel release, with follow-up durations ranging from 3 weeks to 12 months. A comparative overview of study characteristics and outcomes is detailed in **Table 1**.

Table 1 – Synthesis of Included Studies on Carpal Tunnel Syndrome Interventions.

Authors Year	Country	Study Design	Sample Size	Conservative Intervention	Surgical Intervention	Follow-up	Key Outcomes
Sheereen A, et al. (2022)	India/Saudi Arabia	RCT	30	Neurodynamic techniques + tendon gliding	N/A	3 weeks	Comparable pain reduction (VAS) and grip strength improvement across groups.
Fernández-de-las Peñas C, et al. (2015)	Spain	RCT	120	Manual desensitization maneuvers	Surgical decompression	1–12 months	Manual therapy superior in short-term pain relief (NPRS); equivalent functional outcomes (BCTQ) at 6–12 months.
Peter-Okaka U, et al. (2024)	Multinational	Systematic Review	596	Postoperative splinting	N/A	Variable	No significant differences in pain (VAS) or functional recovery (BCTQ) between splinted/non-splinted cohorts.
Multanen et J, al. (2021)	Finland	Retrospective Cohort	259	Pre/postoperative conservative therapy	Carpal tunnel release	1 year	Conservative adjuncts correlated with sustained pain reduction (ΔVAS: −3.2, p<0.01) post-surgery.
Shi Q e MacDermid JC (2011)	Canada	Systematic Review	7	Splinting, corticosteroids, physiotherapy	Surgical release	3–12 months	Surgery demonstrated superior long-term efficacy (BCTQ: MD −1.4, 95% CI −2.1–−0.7); conservative therapy preferred for initial management.
Abdolrazaghi F, et al. (2023)	Iran	RCT	80	Nerve gliding + splinting	N/A	6 weeks	Splinting alone achieved equivalent outcomes to combined therapy (BCTQ: p=0.32).

Source: Júnior DRM, et al., 2025.

Analgesic Efficacy and Functional Outcomes

Conservative modalities, including neurodynamic interventions and manual therapy, demonstrated significant short-term analgesic effects (3–6 weeks), with mean VAS reductions of 2.8–4.1 points (p<0.05) in

RCTs by (SHEEREEN A, et al., 2022) and (FERNÁNDEZ-DE-LAS PEÑAS C, et al., 2015). Neurodynamic techniques, such as nerve gliding exercises, likely reduce pain by decreasing intraneural edema and improving median nerve mobility, as demonstrated in biomechanical studies (COPPIETERS MW, et al., 2009).

Manual therapy, including desensitization maneuvers, may modulate pain perception through central nervous system mechanisms, such as descending inhibitory pathways, which are less explored in CTS literature but align with findings in chronic musculoskeletal pain models (BIALOSKY JE, et al., 2009). These findings align with systematic reviews advocating non-surgical approaches for mild-to-moderate CTS (HUISSTEDE BM, et al., 2010), particularly in populations with occupational risk factors, where early intervention may prevent symptom progression.

Conversely, surgical decompression exhibited sustained pain relief (ΔVAS: −4.5, $p<0.001$ at 12 months) in cohorts with severe CTS, corroborating electrophysiological evidence of median nerve recovery post-decompression (LOUIE DL, et al., 2012). The superior long-term efficacy of surgery may stem from direct mechanical alleviation of nerve compression, which addresses structural pathologies such as fibrosis or synovial hypertrophy.

Functional capacity, assessed via BCTQ, showed comparable improvements between conservative and surgical groups at 12 months (BCTQ-SSS: MD −0.9, 95% CI −1.6–−0.3), suggesting both strategies achieve functional restoration, albeit through distinct mechanisms. For instance, conservative therapies may enhance functional outcomes via improved neuromuscular coordination, while surgery restores baseline nerve conductivity. However, the absence of standardized rehabilitation protocols post-surgery in studies like (MULTANEN J, et al., 2021) complicates direct mechanistic comparisons.

Dynamometric and Electrophysiological Heterogeneity

Grip strength, quantified via hand-held dynamometry, revealed no clinically meaningful differences between treatment arms (mean difference: 2.1 kg, $p=0.12$). This finding contrasts with clinical assumptions that surgical decompression would yield superior grip strength due to nerve recovery. However, grip strength deficits in CTS are multifactorial, involving not only nerve function but also muscle atrophy and disuse patterns, which may persist post-intervention. For example, (ABDOLRAZAGHI F, et al., 2023) reported that splinting alone improved grip strength by 15% in mild CTS, comparable to combined therapy, suggesting that immobilization may mitigate mechanical stressors without requiring adjunct exercises.

A critical gap identified was the underreporting of electrophysiological parameters. Only 28.6% (2/7) of studies included nerve conduction velocity (NCV) or distal motor latency (DML) data. (SHEEREEN A, et al., 2022) noted improved DML (ΔDML: −1.8 ms, $p<0.01$) post-neurodynamic therapy, implying partial neural recovery.

In contrast, (SHI Q e MACDERMID JC, 2011) omitted ENMG data despite analyzing surgical outcomes, which limits understanding of structural versus functional recovery. Electrophysiological metrics are essential for objectively quantifying nerve health, yet their omission in most studies reflects a systemic bias toward patient-reported outcomes (PROs). This methodological inconsistency undermines the integration of structural and functional recovery metrics, particularly in RCTs where PROs may be influenced by placebo effects or subjective bias.

Methodological Limitations and Clinical Implications

Heterogeneity in study designs and outcome measures complicates cross-trial comparisons. For example, (PETER-OKAKA U, et al., 2024) challenged postoperative splinting efficacy in a meta-analysis (n=596), reporting no differences in pain or function between splinted and non-splinted groups. This contrasts with clinical guidelines endorsing splinting to reduce postoperative edema (AMERICAN ACADEMY OF ORTHOPAEDIC SURGEONS, 2016). The discrepancy may arise from variability in splinting protocols: studies using rigid splints versus dynamic braces, or differing durations of immobilization, were pooled without subgroup analysis. Similarly, variability in follow-up durations (3 weeks–1 year) obscures long-term efficacy trends.

For instance, (FERNÁNDEZ-DE-LAS PEÑAS C, et al., 2015) found manual therapy superior to surgery at 3 months but equivalent at 12 months, suggesting that initial benefits of conservative care may plateau, while surgical outcomes stabilize later.

Patient stratification further complicates interpretation. Studies like (MULTANEN J, et al., 2021) focused on postoperative conservative therapy in mixed-severity cohorts, whereas (ABDOLRAZAGHI F, et al., 2023) excluded severe CTS. This heterogeneity limits the generalizability of findings to specific clinical subgroups. Additionally, the exclusion of non-English studies (e.g., potential evidence from Asian or African cohorts) and reliance on small-sample RCTs (SHI Q e MACDERMID JC, 2011, n=7) may introduce selection bias and reduce external validity. For example, cultural or occupational differences in CTS prevalence and treatment adherence are poorly represented in the current dataset.

Future Directions

Prospective RCTs should standardize outcome measures, incorporating high-resolution ultrasound or elastography to quantify nerve morphology and stiffness dynamically. Ultrasound elastography, which assesses nerve elasticity, could provide real-time feedback on treatment efficacy, as demonstrated in diabetic neuropathy research (KANTARCI F, et al., 2014). Multicenter trials with extended follow-ups (>24 months) are warranted to elucidate relapse rates and cost-effectiveness. For example, while surgery shows long-term benefits, its cost (2–3x higher than conservative care in U.S. cohorts) may not justify its use in mild cases (LALONDE DH, et al., 2020).

Clinically, a stratified approach—prioritizing conservative therapy for mild CTS (e.g., splinting, corticosteroid injections) and reserving surgery for refractory cases—aligns with value-based care principles. Shared decision-making tools, incorporating patient preferences and occupational demands, could enhance adherence. For instance, manual workers may prioritize rapid functional recovery, favoring surgery, while office workers may prefer non-invasive options.

Finally, integrating biomarkers (e.g., serum neurofilament light chain) or wearable sensors to monitor daily hand use could personalize treatment pathways. These innovations, coupled with standardized electrophysiological assessments, would bridge the current evidence gaps and optimize therapeutic algorithms for CTS management.

CONCLUSION

This systematic review synthesizes evidence from seven studies to elucidate the comparative efficacy of conservative and surgical interventions for carpal tunnel syndrome (CTS). Conservative therapies—including neurodynamic techniques, manual therapy, and splinting—demonstrate significant short-term analgesic effects (3–6 weeks) and functional improvement in mild-to-moderate CTS, aligning with their role in mitigating early-stage nerve compression and neuromuscular dysfunction. Surgical decompression, however, exhibits superior long-term outcomes (≥6 months) in severe or refractory cases, directly addressing structural pathologies like fibrosis and yielding sustained electrophysiological recovery. Functional equivalence between approaches, as measured by the BCTQ, underscores their complementary roles: conservative strategies enhance neuromuscular coordination, while surgery restores baseline nerve conductivity. Critical methodological limitations, including heterogeneity in study designs (e.g., variable splinting protocols, follow-up durations) and underreporting of electrophysiological data (only 28.6% of studies), impede cross-trial comparisons and obscure mechanistic insights. The exclusion of non-English studies and reliance on small-sample RCTs further reduce generalizability, particularly for culturally or occupationally diverse populations. Clinically, these findings advocate for a stratified approach: conservative management (e.g., splinting, corticosteroid injections) for mild CTS and surgical intervention for advanced cases, tailored to patient preferences and occupational demands. Future research must prioritize standardized outcome measures, integrating high-resolution ultrasound elastography to dynamically assess nerve morphology and stiffness, alongside biomarkers (e.g., neurofilament light chain) for objective recovery tracking. Multicenter RCTs with extended follow-ups (>24 months) are essential to evaluate cost-effectiveness, relapse rates, and the role of postoperative adjuncts like splinting. Innovations such as wearable sensors for activity monitoring could further personalize treatment pathways. By addressing these gaps, the field can refine clinical guidelines, optimize therapeutic algorithms, and enhance value-based care for CTS management.

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