CURRENT CONCEPTS REVIEW

Peripheral Nerve Syndromes at the Elbow: A Review of Current Treatments

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Abstract

Peripheral nerve compression syndromes at the elbow include Cubital Tunnel Syndrome (CuTS), Radial Tunnel Syndrome (RTS), Posterior Interosseous Syndrome (PINS), Pronator Teres Syndrome (PTS), and Anterior Interosseous Nerve Syndrome (AINS). These conditions, though rare compared to carpal tunnel syndrome, can cause debilitating motor and sensory deficits. This review aims to consolidate the latest evidence about treatments to improve therapeutic outcomes and provide clinical recommendations. Conservative treatment is usually first-line and includes physical therapy, splinting, nonsteroidal anti-inflammatory drugs (NSAIDs), and corticosteroid injections. Despite limited evidence, NSAIDs remain widely used due to their cost-effectiveness. Corticosteroid injections offer potential short-term relief and diagnostic value, particularly in CuTS, where non-responders may require alternative diagnoses. Splinting shows variable success, with most patients reporting symptom improvement, while nerve glide exercises and patient education are essential for managing provocative movements. Surgical intervention is indicated when conservative treatments fail. The mainstay surgical therapy for elbow nerve entrapment is decompression. Still, new evidence suggests a difference between management for the various entrapments. Minimally invasive techniques have shown promising outcomes with reduced recovery times. Future research on elbow nerve entrapments should aim to establish a treatment algorithm and to advance minimally invasive techniques.

Level of evidence: V

Keywords: Conservative treatment, Cubital tunnel syndrome, Diagnosis, Peripheral nerve compression syndromes, Surgical decompression

Introduction

Peripheral nerve syndromes of the elbow and forearm, though less common than those of the hand and wrist, are frequently encountered in clinical practice. The ulnar, radial, and median nerves, along with their branches—the posterior interosseous nerve (PIN) and anterior interosseous nerve (AIN)—are particularly vulnerable to compression as they traverse intricate structures.[1] Pulleys and sheaths facilitate nerve gliding, but traction and compression forces, combined with factors like capsule thickening, adhesions, or heterotopic ossifications, can lead to mechanical neuropathy.[2]

The biomechanical complexity of the elbow and forearm makes these nerves highly susceptible to compression syndromes, leading to a significant decrease in function and increased patient morbidity.[3] This review consolidates current insights into the treatment of these syndromes, providing clinicians with a comprehensive understanding of treatment strategies and prognostic considerations, ultimately enhancing patient care and informed decision-making.

Main body

Etiology and Risk Factors

Cubital tunnel syndrome (CuTS) results from compression, stretching, or friction of the ulnar nerve as it passes through the cubital tunnel beneath the Osborne ligament.[4] Repetitive or prolonged elbow flexion exacerbates symptoms due to the anatomical relationship of the nerve with the elbow's

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structures, reducing the canal's volume by 55% and stretching the nerve by 4.7 to 8 mm during flexion.[5] Smoking is a risk factor, likely due to nicotine-induced ischemia, while individuals in physically demanding jobs also face increased risk.[5] Radial tunnel syndrome (RTS) is primarily caused by compression at the arcade of Frohse, the loop of Henry, or hypertrophic forearm muscles, leading to PIN entrapment.[6] The arcade of Frohse is the most common site of PIN syndrome (PINS), which may arise from trauma, rheumatoid arthritis, brachial neuritis, or spontaneous compression.[7,8] Repetitive pronation and supination increase the risk of RTS and PIN syndrome.[7,8] Median nerve compression most commonly occurs in the pronator canal between the humeral and ulnar heads of the pronator teres muscle, often due to hypertrophy from repetitive grasping or pronation, with high-risk activities including prolonged hammering, ladling food, washing dishes, and playing tennis.[1] AIN syndrome (AINS), once thought to be compressive, is now recognized as an immune-mediated motor axonopathy characterized by CD8+ T-lymphocyte infiltration, fibrosis, and edema.[9]

Epidemiology

CuTS is the second most common compressive neuropathy of the upper extremity, affecting up to 5.9% of the general population. However, the true prevalence may be underestimated due to self-treatment and diagnostic challenges.[5,10] Diagnosis relies on nerve conduction studies and physical examination, though severe cases may yield normal results.[5] The average age of CuTS patients is 46 years, with White individuals (74%) being more commonly affected than Black (22%) and Hispanic (3%) populations.[5] Radial nerve compression ranks as the third most common upper limb neuropathy, with PINS having an estimated annual incidence of 0.03%.[3,11] Proximal median nerve compression syndromes are poorly studied but account for less than 1% of upper extremity compression neuropathies.[1] RTS is rare, with only 1% of forearm entrapment syndromes diagnosed as RTS, and incidence rates reported between 2.97 and 3.53 cases per 100,000 person-years, peaking in middle age.[3] Pronator teres syndrome primarily affects men, with an average diagnosis age of 50 years.[12]

Clinical Presentation and Diagnosis

Diagnosis of nerve compression syndromes follows a stepwise approach.[13] The first step is a physical exam [Table 1]. Ultrasound is often the next step, offering a cost-effective and accurate method for identifying nerve entrapments, though its effectiveness depends on operator skill.[13-16] MRI and CT imaging are the next steps, providing detailed views of nerve damage and bone involvement, respectively.[16] Finally, electromyography (EMG) evaluates motor and sensory nerve function, with findings like prolonged distal latency and reduced amplitudes indicating entrapment.[16,17] However, EMG is invasive and cannot localize the entrapment site.[16]

Table 1. Physical Presentation of Elbow Nerve Entrapments

Nerve syndromes	Sensory changes	Motor deficits	Pain/tenderness distribution
Ulnar Nerve (Cubital Tunnel Syndrome)	Numbness and tingling in the 4th-5th digits; dorsal ulnar cutaneous area[14]	Weakness in the flexor digitorum profundus IV-V, abductor digiti minimi; reduced grip[14]	Tenderness over the medial epicondyle; Tinel sign (+)[14]
Median Nerve (Pronator Teres Syndrome)	Rare Parasthesias in thumb-radial ring finger[17]	Weakness in flexor pollicis longus, flexor digitorum profundus II, flexor carpi radialis[17]	Tender lacertus fibrous; Tinel's sign (+) & Scratch collapse test (+)[17]
Median Nerve (Anterior Interosseous Syndrome)	None (pure motor)[13]	Weakness in flexor pollicis longus, flexor digitorum profundus II–III, and pronator quadratus; cannot make 'OK' sign[13]	Forearm pain near the origin of AIN; no tenderness at wrist[13]
Radial Nerve (Radial Tunnel Syndrome)	Paresthesia in the dorsolateral hand if the superficial radial nerve is involved[13]	None (Pure sensory)[13]	Aching lateral elbow/forearm pain with activity; no weakness[13]
Radial Nerve (PINS)	None (pure motor)[13]	Weak wrist/finger extension; radial deviation due to extensor carpi radialis brevis sparing[13]	Pain over the lateral forearm; tenderness near the supinator[13]

Conservative Treatment

Conservative treatment is often recommended as first-line treatment for all nerve syndromes at the elbow and generally consists of physical/occupational therapy, education/activity modification, non-steroidal anti-inflammatory drugs (NSAIDs), steroid/lidocaine injection, and splinting. A recent systematic review and meta-analysis by Natroshvili et al. found that conservative treatment improved 9/10 patients with ulnar nerve compression at the elbow.[18] Specifically, 54% of patients who received steroid/lidocaine injection reported improvement in their symptoms, while up to 89% reported improvement when using a splint device. Similarly, patients with radial and median nerve compression at the elbow typically respond well to conservative therapy.[19]

Pharmacologic Treatment

Pharmacologic treatment of nerve injuries at the elbow is usually limited to oral NSAIDs and corticosteroid/lidocaine injections, although the evidence surrounding the effectiveness of these interventions is limited.[20] A Cochrane review from 2015 investigating the effectiveness of NSAIDs for treating neuropathic pain concluded that there is "insufficient evidence to support or refute the suggestion that oral NSAIDs have any efficacy in any neuropathic pain condition." However, this meta-analysis did not include studies investigating peripheral nerve injuries at the elbow and, therefore, has poor generalizability to this patient population. Despite a relative lack of evidence supporting their use, NSAIDs are often still used in clinical practice as a first-line treatment option for neuropathies at the elbow, likely due to historical use and cost-effectiveness.

In addition to NSAIDs, gabapentinoids (i.e., gabapentin) are sometimes used as an off-label oral pharmacologic intervention for elbow neuropathies, especially CuTS. The authors of this review were unable to find any evidence regarding the effectiveness of gabapentinoids for use in CuTS or other elbow neuropathies. A randomized-controlled trial by Hui et al. found that gabapentin was not more effective than a placebo in the treatment of carpal tunnel syndrome (CTS).[21] As CTS is also a peripheral nerve pathology, the results of this study may be generalizable to patients with CuTS. Future studies should be conducted to assess the effectiveness of gabapentinoids for the treatment of peripheral nerve syndromes at the elbow.

Injection therapy has been shown to be effective for treating ulnar, median, and radial nerve injury at the elbow; however, with mixed results. One study of 25 patients with radial nerve compression at the elbow demonstrated complete resolution of pain in 72% of patients following 2 ml 1% lidocaine and 40 mg of triamcinolone.[8] Additionally, a review of ultrasound-guided corticosteroid injection for CuTS by Gronbeck et al. demonstrated good short-term relief of symptoms; however, a randomized-controlled trial by van Vleen et al. demonstrated no difference in long-term outcomes between ultrasound-guided injection and placebo in CuTS.[22,23] Although the long-term effectiveness of corticosteroid injections is debatable, they may provide some diagnostic utility for elbow neuropathies. Gronbeck et al. suggested that patients who did not respond at all to corticosteroid injection at the cubital tunnel probably did not have CuTS in the first place and, therefore, other diagnoses should be explored.[22] Thus, corticosteroid injections may serve both as a treatment option and a diagnostic tool, aiding in management and potentially reducing unnecessary decompression surgeries in patients unresponsive to conservative care.

Splinting

Night splinting is a simple and cost-effective conservative treatment option for neuropathies at the elbow. A pooled analysis of five studies investigating the effectiveness of splints for ulnar neuropathy at the elbow reported improvement in 89% of patients.[18] The splints were made from various materials, including neoprene, polyform, and thermoplastic, with wear times ranging from 0.5 to 72 months, averaging 19 months.[18] However, while 89% of patients showed some level of improvement, the pooled analysis could not determine the magnitude of these improvements.[18] In contrast, a 2009 randomized controlled trial by Svernlov et al. found that night splinting alone did not improve patient satisfaction or diurnal pain in individuals with ulnar neuropathy at the elbow. Instead, nerve glide exercises combined with patient education were more effective.[24] Despite these mixed findings, splinting remains a straightforward and cost-effective initial treatment option for elbow neuropathies.

Physical Therapy

Physical therapy is commonly prescribed as part of a conservative treatment plan for nerve entrapment at the elbow. It encompasses a variety of treatment modalities, including manual therapy, nerve glide exercises, patient education, low-level laser therapy (LLLT), therapeutic ultrasound (US), and others. This diversity of interventions makes it challenging to isolate the effectiveness of any single modality. Nonetheless, physical therapy as a whole has been shown to reduce pain and improve function in patients with nerve entrapment at the elbow.[25]

A small study by Oskay et al. reported that 100% of patients experienced symptom improvement following nerve mobilization and therapeutic ultrasound, with an average follow-up of one year.[26] Similarly, a study involving 32 patients found that 69% reported symptom relief after three months of treatment with US or LLLT.[26] Notably, both studies focused exclusively on ulnar nerve compression, leaving the effects of physical therapy on radial and median nerve entrapment at the elbow less well-documented. Despite this, nerve glide exercises tailored to the entrapped nerve site are often recommended for these cases as well.[27] While evidence for certain modalities and nerve types remains limited, physical therapy offers a non-invasive, multifaceted approach that can significantly improve outcomes for many patients.

Surgical Advances and Timing

The optimal timing for surgery varies across studies and depends on symptom severity and clinical presentation [Table 2].[28-32] When surgery is pursued, decompression is the mainstay procedure [Table 3].[33-39] As an alternative to surgery, ultrasound-guided hydrodissection has shown promise. One study reported symptom resolution in patients with RTS treated with perineural hydrodissection.[40] Another study demonstrated its use in CuTS, although outcomes remain inconsistent.[38] These findings highlight a potentially effective, minimally invasive approach to managing nerve entrapments. However, more research is needed to confirm its benefit, especially for median and radial nerve compression, where hydrodissection remains largely unexplored.

Table 2. Indications for Surgery

Nerve Syndrome	Indications for Surgery
Ulnar Nerve (CuTS)	Failure of conservative treatments, severe nerve compression, progressive neurological deficits, and recurrence of symptoms[28]
Median Nerve (PTS)	Persistent symptoms despite several months of conservative treatment, significant forearm pain, sensory disturbances, weakness in wrist pronation/flexion, severe thenar atrophy, confirmed motor weakness, and anatomical anomalies causing nerve compression[29–31]
Median Nerve (AINS)	Symptoms persist beyond six months of conservative management, and significant muscle weakness unresponsive to nonoperative care[2]
Radial Nerve (RTS)	Persistent symptoms after conservative treatment, particularly in cases involving multiple entrapments, lateral epicondylitis, or workers' compensation cases[32]
Radial Nerve (PINS)	Persistent symptoms after at least three months of conservative treatment[7]

Table 3. Outcomes of Surgical Intervention

Nerve	Condition	Interventions	Outcomes/Findings	Alternative/Adjunctive Treatments
Ulnar Nerve	CuTs	Submuscular Transposition (SMT), Subcutaneous Transposition (SCT), Open Decompression, Endoscopic Decompression	Endoscopic: smaller incision and fast recovery[33]; no difference in response-to-treatment among four techniques[34]	Supercharged motor nerve: significant improvements more than techniques alone[35]
	---	SMT for refractory CuTs	Superior to SCT and neurolysis if decompression fails[9]; higher complication rates but fewer hypertrophic scars[34]	Post-operative phonophoresis: improvements in nerve conduction velocity (NCV), numeric pain rating scale (NPRS), and Quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH) [36]
Median Nerve	PTS	Ultrasound-guided percutaneous release under wide-awake local anesthesia no tourniquet (WALANT)	Muscle power fully recovered at follow-up. Pain scores (VAS) dropped significantly from 6.2 to 2.5 at week 1 and 0.6 at week 4. All employed patients resumed work by week 1 (*P<0.001*)[37]	Tendon transfers: results inconsistent[2]
		Minimally invasive wide-awake surgery	Postoperative DASH scores (Quick, activity, work) improved significantly vs. pre-op (*P<0.001*), with high patient satisfaction (VAS) reported[17]	
	AINS	Endoscopic decompression	Internal and external neurolysis—via minimal or wide incision—led to	
		Internal neurolysis	≥M4 strength recovery in 82% of pat ≥M4 strength recovery in 77% of patients[2]	

Table 3. Continued

Radial Nerve	RTS	Decompression	Success rate: 92% to 95%[38] improved VAS and QuickDASH score compared to steroid injections[39]	Doppler flowmetry with endoscopic decompression reduces incision length and recovery time[40]
	PINS	Decompression	Good prognosis; patients may continue to improve months after surgery[7]	PINS

In CuTS, various surgical techniques appear to have comparable outcomes.[41] Previous studies have suggested higher reoperation rates among in-situ decompression,[42–44], while the most recent research[41] suggests no difference in reoperation rates [Table 3].

While decompression is commonly used in RTS, its effectiveness is debated, with recent data suggesting lower success rates than earlier studies.[40,45] Both CuTS and RTS would benefit from additional high-quality comparative studies to clarify optimal surgical approaches and improve patient outcomes. Recommendations for RTS are especially limited due to its rarity and the small volume of published research [Table 3].[45]

Minimally invasive decompression techniques have shown efficacy in treating PTS, with approaches like ultrasound-guided percutaneous release leading to improved functional outcomes, pain reduction, and faster recovery.[17,37] This method reduces scarring and supports quicker return to activities. In AINS cases unresponsive to conservative therapy, internal neurolysis has demonstrated superior muscle strength recovery.[2] Tendon transfers may serve as a limited salvage option for patients who do not regain motor function after conservative or surgical treatments [Table 3].

Emerging Research Directions

One of the most pressing challenges in managing peripheral nerve syndromes is the lack of high-quality comparative studies, particularly for rarer conditions such as RTS, PINS, and AINS.[46,47] Future research should prioritize establishing standardized diagnostic algorithms integrating advanced imaging modalities, electrodiagnostic studies, and biomechanical assessments. Additionally, understanding the immune-mediated mechanisms underlying certain syndromes, such as AINS, could pave the way for targeted pharmacological interventions.

Moreover, innovations like ultrasound-guided hydrodissection and focused rehabilitation protocols show promise but require rigorous validation in diverse patient populations. Exploring non-invasive diagnostics and therapies aligns with minimizing patient burden while optimizing outcomes.

Conclusion

Peripheral nerve entrapment at the elbow poses significant challenges in clinical practice. Early recognition and appropriate diagnostic strategies—primarily through clinical examination supplemented by imaging modalities like ultrasound and MRI—are essential for guiding treatment [Table 4]. While conservative measures, including splinting, physical therapy, and pharmacologic interventions, remain the mainstay for initial management, surgical decompression is warranted in refractory cases. The mainstay surgical therapy for elbow nerve entrapment is decompression with variable timing depending on the nerve. Still, new evidence suggests a difference between management for the various entrapments [Table 4]. The future of research on peripheral nerve entrapments of the elbow lies in establishing treatment algorithms and advancing minimally invasive techniques.

Table 4. Clinical Recommendations

	Evidence Rating
Elbow nerve entrapments should be clinically diagnosed using special physical exam maneuvers. If there is uncertainty with localization for treatment, use ultrasound.[14–16]	C
Corticosteroid/lidocaine injections offer short-term symptom relief and diagnostic value for elbow nerve entrapments, helping to identify non-neuropathic cases and potentially reduce unnecessary surgeries.[8,18,19,22,23]	B
Minimally invasive techniques such as ultrasound-guided release are effective for PTS and AINS.[2,17,28]	B
Tendon transfers may be considered in AINS if neurolysis and conservative treatment fail.[2]	C
If the primary surgical intervention of CuTs results in refractory symptoms, the superior reoperation technique is submuscular transposition (SMT).[9]	B

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