International Orthopaedics (2025) 49:871–880
https://doi.org/10.1007/s00264-025-06473-9

RESEARCH

Return to play and outcomes of surgically treated upper limb nerve entrapment in athletes: a systematic review

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Received: 16 February 2025 / Accepted: 20 February 2025 / Published online: 1 March 2025

Abstract

Purpose Athletes face a higher risk of upper limb nerve entrapment due to repetitive stress, trauma, and biomechanics. Diagnosis is challenging, and delayed treatment can impair performance. When conservative care fails, surgery may be needed to restore function and enable return to play (RTP).

Methods This systematic review adhered to PRISMA guidelines and evaluated surgical outcomes, RTP rates, and complications in athletes with upper limb nerve entrapment. A comprehensive search was conducted using MeSH terms and keywords for surgical interventions, nerve entrapment syndromes, and sports. Eligible studies included case series, cohort studies, and comparative studies that reported postoperative outcomes in athletes. Data extraction included nerve involvement, surgical techniques, clinical outcomes, and RTP rates.

Results Thirty-one studies, comprising 1,297 athletes across 23 sports, were included. The most common nerve entrapments involved the ulnar nerve (50.1%), brachial plexus (39.2%), and suprascapular nerve (9.5%). Surgical interventions included ulnar nerve decompression/transposition, first rib resection with scalenectomy for thoracic outlet syndrome (TOS), and suprascapular nerve decompression. RTP rates ranged from 62 to 100%, with an average of 87%. Suprascapular nerve decompression had the highest RTP success (100%), while TOS demonstrated greater variability (62.5–97%). Functional improvements included pain reduction, increased grip strength, and enhanced patient-reported outcomes. The overall complication rate was low, but TOS procedures had the highest reoperation rates (3.8–27%).

Conclusion Surgical treatment of upper limb nerve entrapment in athletes yields high RTP rates and functional recovery. Ulnar and suprascapular nerve decompressions show consistent success, while TOS surgery outcomes vary.

Keywords Nerve entrapment · Athletes · Upper limb · Surgical intervention · Return to play

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Introduction

Athletes can be particularly susceptible to nerve entrapment injuries due to the substantial mechanical stresses, repetitive motions, and sport-specific biomechanics inherent in training and competition. Unlike the general population, where nerve entrapments often arise from systemic conditions or occupational hazards, athletes frequently develop these injuries secondary to muscle hypertrophy, direct trauma, and sustained mechanical loading. Research suggests that upper limb nerve entrapments account for the majority of sports-related nerve injuries, with approximately 88% of cases involving the upper extremity [1]. Among these, commonly reported conditions include transient brachial plexopathies—often referred to as "burners"—along with cervical radiculopathies and entrapments of the median, axillary, ulnar, and suprascapular nerves [1].

Diagnosing upper limb nerve entrapment in athletes presents a challenge due to its symptom overlap with musculoskeletal injuries, variability in clinical presentation, and the potential for compensatory movement patterns that can obscure or exacerbate the underlying neuropathy [2, 3]. Furthermore, athletes may delay seeking medical evaluation due to their high pain tolerance and competitive drive, increasing the risk of prolonged nerve dysfunction and subsequent performance decline [4]. A precise diagnosis requires a thorough understanding of sport-specific biomechanics, alongside careful examination, electrodiagnostic studies, and advanced imaging techniques, to effectively distinguish nerve entrapment from other sources of upper limb pain and dysfunction [2, 5].

When conservative treatment fails to provide adequate symptom relief, surgical intervention may be necessary to decompress the affected nerve and restore function. However, the decision to proceed with surgery is particularly complex in athletes, as it must balance symptom resolution with the imperative of returning to pre-injury performance levels. Postoperative rehabilitation plays a crucial role in neural recovery, optimizing strength and mobility, and ensuring a safe and effective return to competition. The timing of return to play (RTP) is a critical consideration, as premature resumption of activity may predispose the athlete to reinjury or suboptimal functional outcomes [6].

Given these complexities, this systematic review aims to comprehensively assess the prevalence, diagnosis, management, and outcomes of upper limb nerve entrapment injuries in athletes. By synthesizing current literature, we seek to provide a deeper understanding of these conditions and offer insights into optimizing management and RTP for affected athletes.

Materials and methods

This systematic review was conducted with strict adherence to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [7]. The study focused on evaluating the outcomes, RTP, and complications associated with surgically treated upper limb nerve entrapment in athletes.

Search strategy

Eligible articles included all studies from database inception until the search date of January 19, 2025. The search strategy was designed to identify studies examining surgical interventions for upper limb nerve entrapment in athletes, utilizing a combination of MeSH terms and keyword searches. The search terms incorporated variations of surgical procedures (e.g., "surgical intervention," "surgery") and nerve entrapment syndromes affecting the hand, wrist, elbow, shoulder, and upper limb nerves (e.g., "ulnar nerve," "radial nerve," "median nerve," "brachial plexus," "carpal tunnel syndrome," "cubital tunnel syndrome," "thoracic outlet syndrome"). Additionally, athlete-specific keywords (e.g., "sports," "baseball," "tennis," "weightlifting," "gymnastics," "rock climbing") were included. The complete search strategy, including database-specific adaptations, is available in supplementary Fig. 1. Narrative and systematic reviews were excluded using database-specific filtering tools when available.

Eligibility criteria

Studies were included if they were case series, cohort studies, or comparative studies of surgical treatment for upper limb nerve entrapment in athletes and reported postoperative complications or clinical outcomes. Only studies published in English were considered. Studies were excluded if they were reviews, meta-analyses, editorials, case reports, biomechanical studies, or cadaver studies, or if outcomes were not specific to athletes as these did not provide direct clinical data relevant to the study objective.

Study screening

Two authors (JL, DS) performed an independent and blind title and abstract screening. For the full-text review phase, two authors screened the eligible articles independently and blindly, and any discrepancy was resolved by a third author (AL) to reach a consensus.

Data extraction process and data items

Two authors extracted and summarized data from included articles independently, using Google Sheets (Google LLC, Mountain View, CA, USA). Extracted data included study title, author name and year, Covidence ID, and study design. Key clinical variables collected were the nerve(s) involved, entrapment site, and name of the syndrome. Study population details included sample size, type of sport or athlete, and etiology of nerve entrapment. Clinical presentation was assessed through recorded signs and symptoms, associated injuries, and prior nonoperative treatments. Surgical data included the type of operative treatment, rate of operative treatment, and the number of patients in each group. Outcomes assessed included measured clinical results, complications, reoperation rate, and RTP rate. These variables were systematically analyzed to evaluate the effectiveness of surgical intervention in treating upper limb nerve entrapment in athletes.

Results

Study selection and inclusion

A total of 1,863 references were imported for screening. After removing 727 duplicates identified by Covidence, and two studies manually, 1,134 studies remained for title and abstract screening. Among these, 1,036 studies were excluded. The remaining 98 studies were assessed for full-text eligibility, and 67 studies were excluded. Twenty-two studies were non-surgical, sixteen involved a non-athlete population, and nine studies included pediatric patients with no distinct sub-analysis available for adult athletes. Six studies were non-English, six had the wrong exposure, and three examined the wrong outcomes. Two studies had no full text available, and one study was excluded for being anatomical. One study was a case report involving a single patient, and one was a letter or editorial. In total, 31 studies were included in the final analysis [6, 8–37]. The study selection process is illustrated in the PRISMA flow diagram shown in Fig. 1.

Study and athlete demographics

A total of 1297 athletes from 31 studies were included in this systematic review, consisting of 23 of different sports. The majority participated in high-impact and overhead sports such as baseball/softball, volleyball, wrestling, weightlifting, swimming, and gymnastics as shown in Fig. 2. The most frequently studied nerve entrapments involved the ulnar nerve (650 patients, 50.11%) (cubital tunnel syndrome, guyon's canal), brachial plexus (509 patients, 39.2%) (thoracic outlet syndrome), and suprascapular nerve compression (123 patients, 9.5%) (spinoglenoid or scapular notch

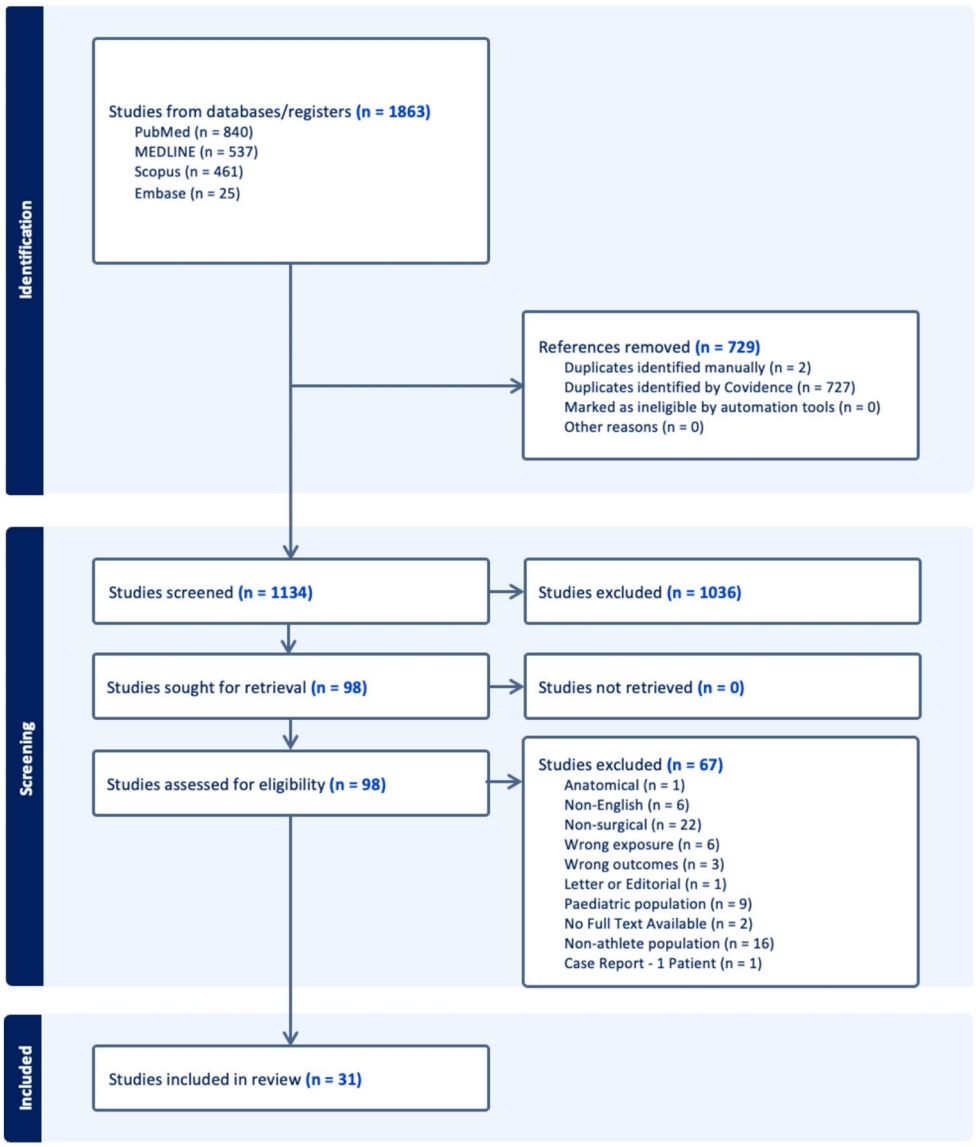

Fig. 1 PRISMA flow diagram outlining study selection and screening

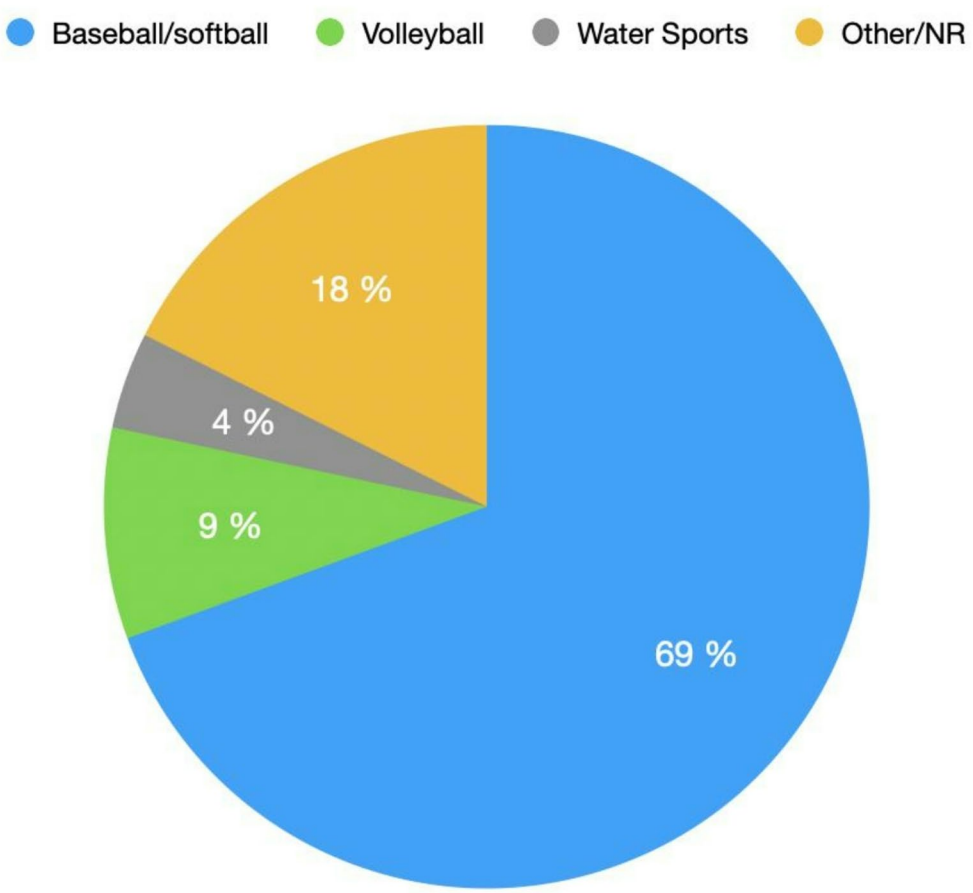

Fig. 2 Sports Representation in studies included in this systematic review on upper limb on surgically treated nerve entrapment in athletes

entrapment) as outlined in Fig. 3. The primary causes of entrapment included frank trauma, repetitive microtrauma, impingement of surrounding musculature or ligaments on the nerve, and unreported causes.

Study characteristics

This review included 24 retrospective cohort studies including 1,272 patients, and seven case series including 25 patients, with sample sizes ranging from four to 500 athletes. All studies evaluated surgical management, with a primary focus on RTP and functional recovery. The most common surgical procedures included subcutaneous ulnar nerve transposition and decompression for cubital tunnel syndrome, first rib resection and scalenectomy for thoracic outlet syndrome, and suprascapular nerve decompression for suprascapular entrapment.

Return to play outcomes

The overall RTP rate varied from 60% to 100%. Athletes undergoing ulnar nerve decompression/transposition reported RTP rates between 60% and 100%. Neurogenic thoracic outlet syndrome cases demonstrated RTP rates ranging from 62.5% to 100% after first rib resection and scalenectomy. Suprascapular nerve entrapment surgeries showed some of the highest success rates, with 97% to 100% of athletes RTP within six to 12 months. Surgical treatment for suprascapular nerve entrapment can vary and may involve decompression of the suprascapular nerve, resection of the superior scapular ligament, shaving of the scapular spine base, or spinoglenoid notchplasty as shown in Table 1.

Functional outcomes

Functional outcomes improved across studies, with reductions in pain, improved grip strength, and better patient-reported scores. Changes in objective measures reported after surgical intervention included need for pain medication, with 80% of athletes reporting reduced need after TOS decompression according to one study [9]; return of premorbid or near-premorbid strength after surgical intervention for cubital tunnel syndrome, quadrilateral space syndrome, and suprascapular nerve compression over six studies; improved postoperative ROM for quadrilateral space syndrome and suprascapular neuropathy in two studies; and reduced muscular atrophy after suprascapular nerve neuropathy surgical

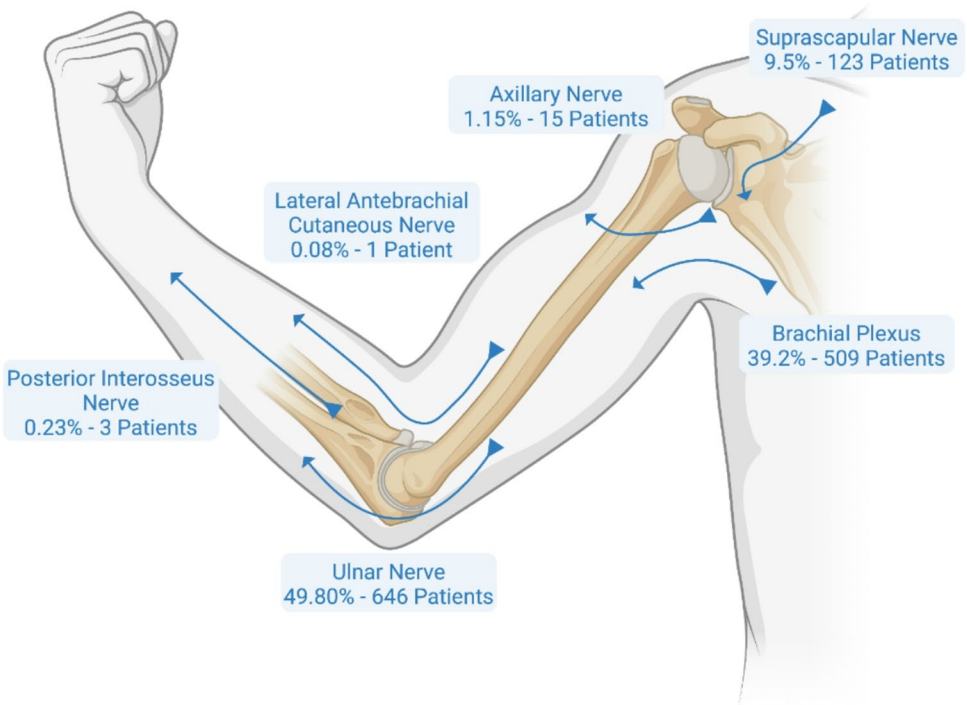

Fig. 3 Anatomical Localization of Common Upper Limb Nerve Entrapments Sites in Athletes

treatment in three studies. One study specifically reported increased grip strength in TOS patients from 32.2 kg preoperatively to 37.8 kg postoperatively [11]. Another targeted suprascapular nerve release led to significant improvements, with external rotation strength increasing from 50% of the unaffected limb's strength preoperatively to 80–90% post-surgery [16]. Patient-reported outcomes also improved, with reduced postoperative pain and tenderness reported in studies examining brachial plexus, ulnar, axillary, and suprascapular nerve compression, reported in 14 studies as shown in Fig. 1. Patients reported improved ability to perform activities of daily living after intervention for TOS and ulnar nerve compression in six studies. One study reported a DASH score recovery rate of 79.8%. Another study, showed significant improvements in the Kerlan-Jobe Orthopaedic Clinic Score for ulnar neuropathy cases, with symptom outcomes as follows: resolved in five patients (33.3%), improved in eight patients (61.5%), and no change in two patients (6.7%) [31].

Complications and reoperation rates

Complication rates were low but varied depending on the procedure. The overall complication rate ranged from 0 to 27%, with thoracic outlet decompression surgeries displaying an average complication rate of 11.7%. Infection was reported in 6.25% of TOS cases according to one study. Other complications included haematoma, seroma, chylothorax, pneumothorax, haemothorax, atelectasis, lymphorrhea, and stretching of the brachial plexus, during or after TOS surgery in three studies. Ulnar nerve surgeries had a lower complication rate ranging from 0 to 11%, with reoperation necessary in 0–5% of cases [6, 8, 20, 31]. Most patients showed improvement following revision or reoperation. Following axillary and suprascapular nerve decompression procedures, complication and reoperation rates were 0% (5 studies) or not reported (4 studies).

Nonoperative management

Although all studies focused on surgical treatment, several reported failed conservative management before surgery. Nonoperative approaches included physical therapy, activity modification, nerve gliding exercises, and pain management with NSAIDs or corticosteroid injections. Conservative management was most commonly attempted for three to six months before surgery was considered.

Discussion

The findings of this systematic review suggest that surgical intervention for upper limb nerve entrapment in athletes is associated with high RTP rates, symptom relief, and functional improvements. Studies show that neurogenic thoracic outlet syndrome (TOS), suprascapular nerve decompression, and ulnar nerve decompression can be effective in restoring function and reducing pain in athletes [6]. While TOS demonstrated more variable outcomes, particularly in venous cases [9], ulnar nerve and suprascapular nerve

Table 1 Surgical outcomes of nerve entrapment syndromes in Athletes - Study design, treatment, and return to play rates

Author Name + Year	Study Design	Name of syndrome	Sample Size	Operative Treatment	Rate of Operative Treatment	Return to Play Rate
1992, Hama H; et al.,	Case Series	Suprascapular entrapment neuropathy	4	1. resection of superior scapular ligament. 2.lateral edge of the base of the scapular spine was shaved 3, 4.resection of the superior scapular ligament at the scapular notch and shaving of the spinoglenoid notch	100%	100%
2005, Dramis A; Pimpalnerkar A	Case Series	Suprascapular neuropathy	4	surgical decompression of the suprascapular nerve	100%	100%
2008, McAdams TR; Dillingham MF	Case Series	Quadrilateral space syndrome	4	quadrilateral space decompression	100%	100%
2020, Sparapani et al.,	Case Series	Ulnar nerve mononeuropathy	2	surgical exploration, fibrous arch division and release of ulnar nerve	50%	NR
2012, Li X; et al.,	Case Series	Cubital tunnel syndrome	3	isolated release of the anconeus muscle without ulnar nerve transposition	100%	100%
2019, Beteck B; et al.,	Retrospective	nTOS	97 Athletes	first-rib resection and scalenectomy	100%	70%
2024, Funakoshi T; et al.,	Retrospective	TOS	79 Athletes	Endoscopy-assisted transaxillary approach for partial resection of the first rib and complete anterior and partial middle scalenectomies	100%	15% partial return, 81% same level −97% overall RTS rate
1998, Ferretti A; De Carli A; Fontana M	Retrospective	Isolated infraspinatus atrophy	38	Neurolysis of suprascapular nerve	7.90%	100%
2008, Baltopoulos P et al.,	Retrospective	nTOS, mixed TOS, scalenus Anticus syndrome	12 Athlete 16 Cases	Decompression of thoracic outlet by scalenectomy	100%	100%
1998, Sandow MJ; Ilic J	Retrospective	Suprascapular nerve rotator cuff compression	5	Spinoglenoid notchplasy	100%	100%
2020, Nicholson GP et al.,	Retrospective	Ulnar neuropathy	26	anterior ulnar nerve transposition with a subcutaneous technique and a fascia sling	100%	92%
2021,Hadley, C.J.; et al.,	Retrospective	Ulnar neuropathy	15	cubital tunnel decompression and subcutaneous transposition of the ulnar nerve	100%	86.60%
2018, Tsikouris GD; et al.,	Retrospective	Suprascapularnerve compression	56	suprascapular nerve decompression	62.50%	97% decompression; 84% non-decompression
2019, Erickson BJ; et al.,	Retrospective	Cubital Tunnel Syndrome	54	Isolated ulnar nerve decompression/ transposition with or without ulnar collateral ligament reconstruction: 48 (92%) were anterior subcutaneous transpositions, while 2 (4%) were decompressions alone without transposition and 2 (4%) were submuscular transpositions.	100%	62% in all patients; 73.4% in patients with prior UCLR
2024, Talutis SD; et al.,	Retrospective	TOS	32 high school 52 collegiate	surgical decompression by: first rib resection (81; 96.4%); scalenectomy (1; 1.2%); pectoralis minor tenotomy (2; 2.4%)	100%	62.5% in patients with nTOS
2023, Olson EM; et al.,	Retrospective	nTOS	36	Supraclavicular decompression including first rib resection and anterior scalenectomy	36.10%	73%

Table 1 (continued)

Author Name + Year	Study Design	Name of syndrome	Sample Size	Operative Treatment	Rate of Operative Treatment	Return to Play Rate
2022, Arnold MT; et al.,	Retrospective	TOS	22 nTOS	rib resection surgery	100%	82% nTOS
2022, Vaswani R; et al.,	Retrospective	Pronator syndrome for median neuropathy	4	UCL reconstruction, Elbow arthroscopy, posteromedial osteophyte debridement, ulnar nerve transposition (2), UCL reconstruction and Ulnar nerve transposition (1), UCL reconstruction, Elbow arthroscopy, open median nerve decompression (1)	100%	100%
1993, Rettig AC; Ebben JR	Mixed Design	Cubital Tunnel Syndrome	20	Subcutaneous ulnar nerve transfer	100%	95%
1977, Del Pizzo W; et al.,	Retrospective	Ulnar nerve entrapment	19	anterior transfer and placement of the nerve deep to the flexor muscles	100%	60%
1992, Ozaki, J: et al.,	Retrospective	Infraglenoid tubercle ossifications	7	surgical resection of the osteophytes and release of the axillary nerve entrapment	100%	NR
1996, Antoniadis, G.; et al.,	Retrospective	Suprascapular nerve entrapment	16	posterior approach to surgical decompression of the suprascapular nerve	100%	NR
2014, Chandra V; et al,	Retrospective	Thoracic outlet syndrome (neurogenic and venous)	27	supraclavicular approach to decompression, anterior and middle scalenectomy, complete rib resection, and extensive brachial plexus neurolysis	67% of nTOS patients (18)	All patients 85%; nTOS 81%; surgically treated nTOS 83%
2017, Shutze W; et al.,	Retrospective	neurogenic thoracic outlet syndrome	67	first rib resection and scalenectomy	100%	70%
2018, von Bergen TN; Lourie GM	Retrospective	NA	7	(1) surgical release of the LABC nerve with a partial biceps tendon excision for a dynamic compression of the LABC nerve as it emerged from lateral to the biceps tendon and brachioradialis, (2) radial tunnel release with debridement of hypertrophic extensor carpi radialis brevis and extensor digitorum communis muscles for dynamic compression of the PIN and posterior cutaneous nerve, (3,4,5) in situ decompression of the ulnar nerve with excision of the anconeus epitrochlearis	71% (5/7)	100%
2020, Dua A.; et al.,	Retrospective	thoracic outlet syndrome (neurogenic arterial and venous)	22	rib resection via a supraclavicular incision + scalenectomy + brachial plexus lysis	100%	94% all TOS athletes returned to activity
2022, De Giacomo A.F.; et al.,	Retrospective	ulnar neuritis	500	Modified Jobe UCLR, sometimes with transposition (263; 65%); docking technique (116; 29%); DANE-Tj technique (14; 4%); Primary repair (7; 2%)	100%	82% (in ulnar neuritis)
2022, J Gutman M; et al.,	Retrospective	thoracic outlet syndrome (neurogenic and venous)	20	Surgical treatment of thoracic outlet syndrome	100%	74.1% in all patients; 70% of nTOS patients
2024, Chauhan A; et al.,	Retrospective	thoracic outlet syndrome (neurogenic and venous)	36	Thoracic outlet decompression	0.58	all TOS 79%, no significant difference between types of TOS

Table 1 (continued)

Author Name + Year	Study Design	Name of syndrome	Sample Size	Operative Treatment	Rate of Operative Treatment	Return to Play Rate
2024, Jiang D; et al.,	Retrospective	thoracic outlet syndrome (neurogenic arterial and venous)	7	supraclavicular decompression, first rib resection, and scalenectomy of the anterior and middle scalene muscles	100%	86% of nTOS
2025, Porcellini G; et al.,	Case Series	neurogenic quadrilateral space syndrome	4	(1) decompression of the fibrous band entrapping the branch for the teres minor. (2) none. (3) surgical decompression by releasing the fibrous bands from the long head of the triceps to the teres major (4) surgical decompression removing a large fibrous band tense between the long head of the triceps to the teres major	75%	100%

TOS: thoracic outlet syndrome

nTOS: neurogenic thoracic outlet syndrome

UCL: ulnar collateral ligament

UCLR: ulnar collateral ligament reconstruction

NA: not applicable

NR: not reported

surgeries were consistently successful [6, 12, 32, 36, 38]. Complication rates were low, though reoperation was more common in thoracic outlet procedures [9, 14, 39].

Nerve entrapment syndromes in athletes often follow sport-specific patterns [6, 40]. Surgical treatment generally results in good RTP rates, with suprascapular nerve entrapment showing the most predictable recovery [35]. In baseball players, ulnar neuropathy is a common complication, and transposition techniques offer varying success rates depending on the severity of the condition [6, 11, 15, 34, 35, 40]. Thoracic outlet syndrome, frequently seen in overhead athletes, presents diagnostic challenges due to symptom overlap with other conditions, which makes early diagnosis crucial for successful surgical outcomes [35, 39]. First rib resection combined with anterior and middle scalenectomy appears to provide superior outcomes in TOS compared to nonoperative management [41]. Additional studies are necessary to examine outcomes of other thoracic outlet decompression techniques, such as scalenectomy without rib resection, in the athlete population. Suprascapular nerve decompression yields high RTP rates, particularly in volleyball players, where traction-related injuries are common [16, 36]. Compared to conservative treatment, surgery offers more consistent pain relief and restoration of strength [16, 34–36].

Cubital tunnel syndrome is prevalent in throwing athletes due to valgus stress at the elbow [39]. The decision between in situ decompression and transposition remains debated, as transposition may be preferable for athletes requiring extensive elbow flexion [39]. Studies indicate that the presence of an ulnar collateral ligament (UCL) injury can complicate surgical outcomes, often leading to more prolonged rehabilitation times and a lower rate of return to competition [6, 40]. Axillary nerve entrapment and quadrilateral space syndrome remain underdiagnosed and likely underreported, despite favourable surgical outcomes [6, 42]. Similarly, pronator syndrome, a proximal median nerve compression, is also often overlooked, particularly in sports involving repetitive forearm pronation [39]. Distal nerve compressions, including Guyon's canal syndrome and carpal tunnel syndrome, are less common but may occur in athletes requiring repetitive gripping or wrist strain [43].

This review is limited by heterogeneity in study designs, surgical techniques, and rehabilitation protocols. Most studies were retrospective, introducing selection bias, and lacked standardized outcome measures, which made it difficult to make comparisons. Future research should prioritize prospective, multicenter studies with long-term follow up. Follow up studies should assess career longevity and recurrence rates in athletes undergoing surgical decompression for nerve entrapment syndromes. Improved diagnostic algorithms and refinement of surgical indications, particularly for thoracic outlet syndrome, are needed to clarify management and improve treatment strategies. Additional studies are necessary to further characterize the incidence, diagnosis, management, and outcomes of these underdiagnosed nerve entrapments in athletes.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00264-025-06473-9.

Acknowledgements None.

Author contributions J.J.L. and D.S. contributed equally to the manuscript. J.J.L., D.S., A.L., C.C., and E.H. all participated in data collection. J.J.L. and D.S. drafted the main manuscript text. A.L. contributed to data analysis and manuscript revision. C.C. provided critical revisions and expert input on methodology. E.H. supervised the study, provided conceptual guidance, and reviewed the final manuscript. All authors contributed to manuscript editing, reviewed the final version, and approved it for submission.

Funding No funding was obtained for this study.

Data availability No datasets were generated or analysed during the current study.

Declarations

Human ethics and consent to participate Not applicable.

Competing interests The authors declare no competing interests.

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