SYSTEMATIC REVIEW

A Systematic Review of Retrospective Evidence on Patient and Surgical Factors in Recurrent Cubital Tunnel Syndrome

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Abstract

Objectives: There is much debate regarding which patient-related risk factors and surgical techniques contribute to recurrent cubital tunnel syndrome (CuTS). This systematic review aimed to identify preoperative risk factors and surgical techniques associated with symptom recurrence or revision surgery following cubital tunnel release.

Methods: We searched PubMed, Scopus, Cochrane Library, and clinicaltrials.gov databases for potentially eligible articles published between January 2009 and November 2024. Using Covidence, four reviewers screened based on predefined inclusion criteria: studies examining recurrent CuTS following surgery, reporting patient characteristics and/or surgical techniques, and published in English. A standardized Excel sheet was utilized to extract patient demographics, recurrence rates, and revision outcomes. Risk of bias was assessed using the Newcastle-Ottawa Scale. Due to heterogeneity in outcomes, no formal metaanalysis was performed, and a narrative synthesis was done.

Results: Fourteen studies were included, totaling 49,492 patients with idiopathic CuTS treated with ulnar nerve surgery. Revision rates ranged 1.2–23.8%. Younger age was described as a risk factor in ten studies, although one study identified older age as a predictive risk factor. In contrast, another study described it as a protective factor. Diabetes was associated with recurrence risk in two studies, while sex, BMI, and smoking showed inconsistent associations. Severe preoperative symptoms or higher McGowan scores were associated with poorer outcomes in two studies. Overall, recurrence and revision rates were low across all techniques.

Conclusion: The retrospective nature and limited power of included studies increase risk of selection and Type II errors. Regardless, there seems to be no significant difference in recurrence/revision rates based on surgical techniques. CuTR was often recommended as an initial procedure while ulnar nerve transposition (UNT) was reserved for revisions or patients with nerve subluxation.

Level of evidence: III

Keywords: Cubital tunnel syndrome, Reoperation, Risk factors, Surgical decompression, Ulnar nerve compression

Introduction

Cubital tunnel syndrome (CuTS) is the second most common peripheral neuropathy of the upper extremity, behind carpal tunnel syndrome (CTS).[1] According to McGowan, CuTS is caused by ulnar nerve compression within the cubital tunnel at the elbow, often by Osborne's ligament or the two heads of the flexor carpi ulnaris muscle.[2] On exam, patients present with numbness or paresthesia in the ulnar two fingers, altered dexterity, hand weakness, and, in more advanced cases, intrinsic atrophy. Symptoms are exacerbated during sleep and in activities requiring repeated or prolonged elbow flexion. Electromyogram/nerve conduction studies provide

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objective evidence of nerve conduction slowing and signs of demyelination, while ultrasound (US) or magnetic resonance imaging (MRI) evaluate the structure of the nerve.

Nonoperative intervention involves reducing activity that causes elbow flexion, non-steroidal anti-inflammatory drugs (NSAIDs) for comfort, hand therapy, and splints to keep the elbow in extension.[1] If nonoperative strategies fail to control CuTS symptoms, operative intervention is offered in the form of an ulnar nerve in situ decompression, often referred to as a cubital tunnel release (CuTR), or an ulnar nerve transposition (UNT), where the nerve is decompressed and then moved anterior to the medial epicondyle.

There is no concrete consensus regarding which technique is most effective, but the most recent paradigm is to utilize CuTR as first-line treatment whenever possible.[1,3-6] Although the recurrence rates following CuTR are low, persistent symptoms can have a lasting impact on patient satisfaction and recovery.[1] Patients may require revision surgery, which is more extensive, more unpredictable, and can be associated with poorer outcomes. Patient-related risk factors, such as age, sex, body mass index (BMI), smoking status, diabetes, and preoperative symptom severity, are potential contributors to recurrence after release. However, the relative contributions of these factors remain unclear in the literature, in part due to small sample sizes, uncontrolled confounders, and potential institutional bias.[1,7-11]

This systematic review of the literature aims to compile current evidence on recurrence following CuTR, focusing on describing reported associations with patient-related factors. While certain factors have been explored repeatedly, the strengths of their associations with recurrence are unclear and inconsistent. Rather than determining definitive predictors, this review examines current trends and highlights areas of inconsistency in the literature. By identifying and evaluating these predictors, this review seeks to clarify their contribution to outcomes and inform more personalized, evidence-based approaches to the surgical management of CuTS.

Materials and Methods

This study did not involve patients and, therefore, was deemed Institutional Review Board exempt.

Literature Review

This systematic review was conducted in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[12,13] The protocol was registered with International Prospective Register of Systematic Reviews (PROSPERO) (CRD420251055157). We searched PubMed, Scopus, Cochrane Library, and clinicaltrials.gov databases for potentially eligible articles published between January 2009 and November 2024 to ensure up-to-date surgical techniques and patient care protocols. The search strategy incorporated both Medical Subject Headings (MeSH) like "Cubital Tunnel Syndrome"[MeSH], "Ulnar Nerve Compression Syndromes"[MeSH], and "Ulnar Neuropathies"[MeSH], as well as free-text keywords related to cubital tunnel syndrome, ulnar nerve compression, ulnar nerve transposition, and in situ decompression. The full search string is provided in [Supplementary Material 1].

Inclusion and Exclusion Criteria

Inclusion criteria included (1) adult patients >18 years of age, (2) idiopathic CuTS, (3) a full English language manuscript available, (4) discussion of risk factors like BMI, comorbidities, age, self-reported sex, tobacco use, concurrent surgery, surgical technique, and (5) assessment of association with recurrence or revision surgery. Exclusion criteria included the following: inaccessible article, inappropriate setting (release done for any diagnosis other than CuTS), inadequate outcomes (solely subjective outcomes like patient reported outcome measures, or studies without assessment of association with recurrence or revision surgery), inappropriate intervention (not CuTR or UNT), inappropriate study design (case reports, small case series, systematic reviews, and meta-analyses), and inappropriate patient populations (focusing on outcomes of revision surgery only or index surgery only). Using Covidence software, four reviewers (A.G., P.B., J.G., and J.F.) independently screened articles based on predefined inclusion criteria. Conflicts were settled by the senior authors (M.K. and A.I.). If the title/abstract matched our inclusion criteria, the full text was retrieved and reviewed.

Data extraction and assessment of study quality

Two authors (A.G. and P.B.) independently extracted data and assessed the methodological quality of the studies. A standardized data extraction Excel sheet was utilized to collect patient demographics, recurrence rates, and revision outcomes.

The following baseline data were extracted from each study: first author, year of publication, study design, percentage of female participants, mean age, and sample size. Additionally, summary data on patient-related risk factors, including medical comorbidities, preoperative severity, and surgical techniques, were collected and evaluated by two reviewers (A.G. and P.B.). Data was extracted regarding the assessment of recurrence, including reported revision rates, rates of recurrent symptoms, worsening, or non-improvement. Reoperation rates were collected for surgery performed for persistent, recurrent symptoms or ulnar nerve instability only, not for postoperative complications. When available, effect sizes and confidence intervals were extracted. Any disagreements were settled by a third author (J.G.).

The risk of bias was assessed using the Newcastle-Ottawa Quality Assessment Scale.[14,15] This assigns points based on the quality of patient selection, comparability of the cohort, and outcome assessment. Studies scoring 6 points or more were considered to have a higher quality of evidence.

Outcome Measures

After the search was finalized, variables were selected as long as at least three studies evaluated those outcomes. The selected variables include age at surgery, patient sex, BMI, diabetes status, race, concurrent surgery, tobacco use, preoperative severity, and surgical technique. Imaging/electrodiagnostic studies were not evaluated. The outcomes assessed were recurrence or revision versus no recurrence or revision, depending on the study.

Across these studies, odds ratios or comparative data for most risk factors or comorbidities were not consistently reported. P-values were present, but without raw contingency tables or effect sizes, interpretation would have been limited. Given the marked heterogeneity in study design, patient populations, method of assessing recurrence/revision rates, as well as risk factors assessed, meta-analysis was deemed not appropriate.

A narrative synthesis was therefore performed according to the Guidance on the Conduct of Narrative Synthesis in Systematic Reviews.[16] One author systematically summarized each article using bullet points to document key aspects of each study, focusing on methods of statistical analysis used and risk factors studied.

Results

Literature Review

A total of 1044 articles were identified during the initial search. After removing duplicate references, 412 studies were screened for relevant titles/abstracts, identifying 61 studies [Figure 1]. From these 61 studies, a total of 14 studies were included, consisting of 49492 patients with idiopathic CuTS treated with ulnar nerve release or decompression.[7-11,17-25] These included three case-control studies as well as 11 retrospective cohort studies. Study dates span from 2012 to 2024. The average age ranged from 46 to 58 years. In most studies, patients were male. Sample sizes ranged from 74 to 25,977.

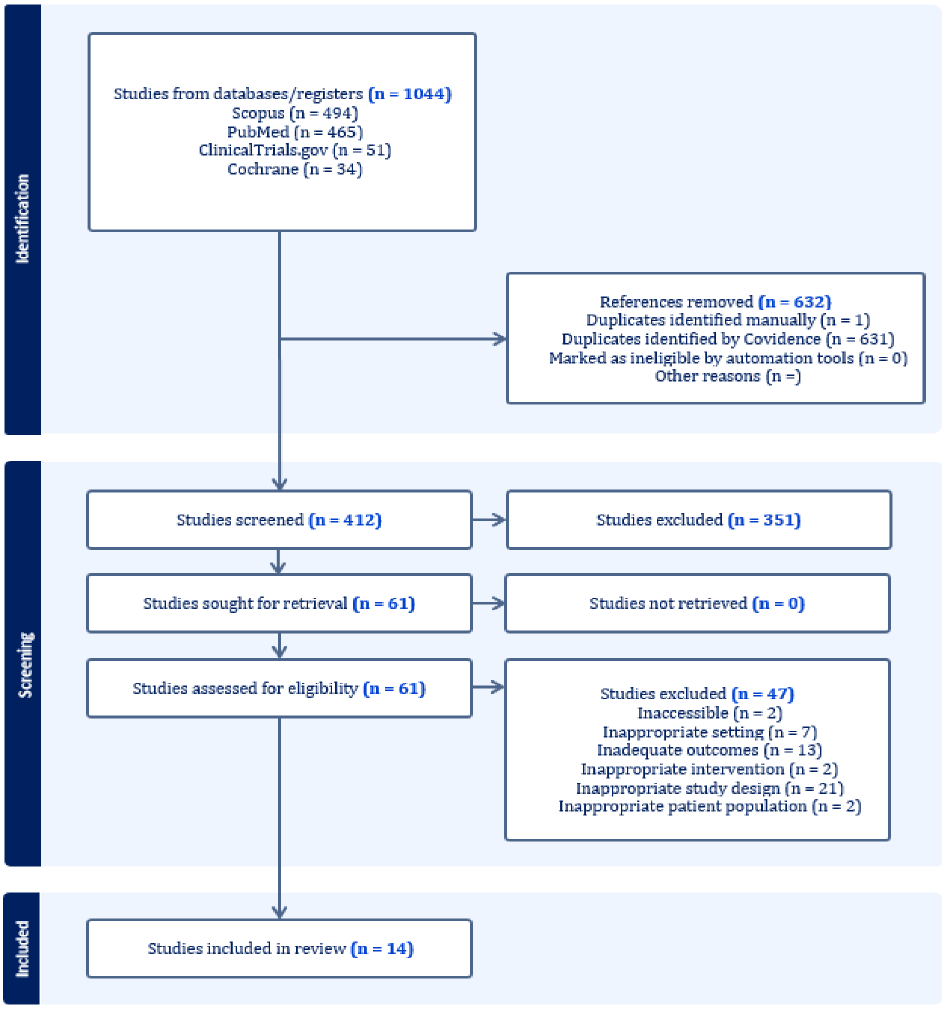

Figure 1. PRISMA Flow Diagram of Search.
CuTR=cubital tunnel release; PRISMA=preferred reporting items for systematic reviews and meta-analyses

Baseline Characteristics and Study Design

Study demographics and extracted variables are described in the following table [Table 1]. Risk of bias assessment was performed in the subsequent table [Table 2]. Twelve studies have a NO score of 6 and above.[7-11, 17-19, 21, 23-25] One study only examined patients with stage III McGowan classification.[10] Eight studies performed a multivariate logistic regression, controlling multiple confounders against each other.[7,8,10,11,18, 23-25]

Table 1. Basic Demographic Data, Study Measures, and Rates of Revision/Recurrence of the Included Studies

Authors	Year	Study Type	N of patients	Percent Female	Mean Age ± SD	Index Procedures Discussed	Objective Measures Compared	Estimated Rates of Revision/ Recurrence
Krogue et. al	2015	Case Control	502	43.2	55 ± 13.3	OISD	Age, sex, median symptom duration, race, BMI, diabetes status, tobacco use, preoperative McGowan score, concurrent surgery	19.1^
VanNest et. al	2020	Case Control	170	60.6	50 ± 14.5	SD, AT	Age, sex, symptom duration, BMI, diabetes status, tobacco use, concurrent surgery	2.8^
Kim et. al	2024	Retrospective Cohort	114	53.5	47 ± 19.2	OISD, EISD	Surgical technique	8.6^
Gökay et. al	2012	Retrospective Cohort	1367	42.3	56.8 Δ 25-59	SCAT	Symptom duration, preoperative McGowan grade	2.9^
Campbell et. al	2024	Retrospective Cohort	132	35.6	47.6 ± 13.9	SD, SCAT	Age, sex, race, symptom duration, BMI, diabetes status, tobacco use, preoperative McGowan score, concurrent surgery	1.2^
Hutchinson et. al	2021	Retrospective Cohort	216	42.6	53 ± 12.1	OISD, SCAT	Age, sex, diabetes status, and surgical technique	18.9^
Gaspar et. al	2016	Case Control	678	54.6	51.4 ± 14.0	OISD	Age, sex, symptom duration, BMI, diabetes, tobacco use, preoperative McGowan grade, concurrent surgery	3.2^
Smit et. al	2023	Retrospective Cohort	115	29.8	56.2 ± 14.3	SD, AT	Age, sex, BMI, diabetes status, tobacco use, and surgical technique	17.7^
Kong et. al	2018	Retrospective Cohort	235	34.5	53.3 ± 10.9	SD	Age, sex, symptom duration, BMI, diabetes mellitus, tobacco use, alcohol use, and preoperative severity	22.6^^
Tong et. al	2018	Retrospective Cohort	146	24.0	58.4 ± 12.5	SD, SCAT	Age, sex, symptom duration, diabetes status, tobacco use, alcohol use	19.2^^
Suzuki et. al	2017	Retrospective Cohort	83	50.6	54 Δ 26-82	SD, AT, decompression with medial epicondylectomy	Age, sex, symptom duration, BMI, diabetes status, preoperative McGowan score, surgical technique	3.6^^
Izadpanah et. al	2021	Retrospective Cohort	74	24.3	54* Δ 18-89	SD, SCAT, SMAT	Age, sex, symptom duration, diabetes status, preoperative McGowan score, and surgical technique	23.8^

Table 1. Continued

Camp et. al	2017	Retrospective Cohort	25977	48.5	n/a	OISD	Age, sex, BMI, diabetes status, tobacco use, alcohol use	1.4^
Schloemann et. al	2023	Retrospective Cohort	19683	43.1	53 ± 14.0	SD, SMAT	Age, sex, race/ethnicity, concurrent surgery, surgical technique	1.4^

SD = in situ decompression (unspecified); OISD = open in situ decompression; EISD = endoscopic in situ decompression; AT = anterior transposition (unspecified); IMAT = intramuscular anterior transposition; SMAT = submuscular anterior transposition; SCAT = subcutaneous anterior transposition; Δ = expressed as a range;* Reported as median age (range); ^ = Rate of revision (%); ^^ = Rate of recurrence (%)

Table 2. New Castle Ottawa Scores of the Included Studies

Study ID	Year	Selection 1: Representativeness of Exposed Cohort	Selection 2: Selection of Non-Exposed Cohort	Selection 3: Ascertainment of Exposure	Selection 4: Outcome Not Present at Start	Comparability 1: Control for Key Factor	Comparability 2: Additional Control	Outcome 1: Assessment of Outcome	Outcome 2: Follow-Up Long Enough?	Outcome 3: Adequacy of Follow-Up	Total Stars*
Krogue et. al	2015	1	1	1	1	1	1	1	1	1	9
VanNest et. al	2020	1	1	1	1	1	1	1	1	1	9
Kim et. al	2024	1	1	1	1	0	0	1	1	1	7
Gökay et. al	2012	0	0	1	0	0	0	0	1	1	3
Campbell et. al	2024	1	1	1	1	0	0	1	1	1	7
Hutchinson et. al	2021	1	1	1	1	1	1	1	1	1	9
Gaspar et. al	2016	1	1	1	1	0	0	1	1	1	7
Smit et. al	2023	1	1	1	1	1	1	1	1	1	9
Kong et. al	2018	1	1	1	0	1	1	1	1	1	8
Tong et. al	2018	1	1	1	1	1	1	1	1	1	9
Suzuki et. al	2017	0	0	1	0	1	1	1	1	1	6
Izadpanah et. al	2021	1	1	1	1	0	0	1	1	1	7
Camp et. al	2017	1	1	1	0	1	1	1	1	1	8
Schloemann et. al	2023	1	1	1	1	1	1	1	1	1	9

Green – Case control study; Red – Retrospective cohort study; *Maximum Newcastle–Ottawa (NO) score is 9

Narrative Synthesis of Comorbidities

Age:

Twelve studies evaluated patient age at surgery.[7-11,17,18, 21-25] Two studies evaluated age around their sample size mean as a categorical variable.[7,8] Another two studies analyzed age as a categorical variable or continuous variable in different stages of the analysis.[11,23] The remainder compared age as a continuous variable or scaled age using intervals.[9,10,17,18,21,22,24,25] Krogue et al. and Suzuki et al. established no significant association.[17,25] Schloemann et al. suggested that older age was protective against recurrence. In contrast, Tong et al. argued that it was a predictive factor.[10,24] All other studies reported younger age as a predictive factor.[7-9,11,17,18,21-23,25]

Sex:

Twelve studies evaluated patient sex.[7-11,17,18,21-25] Hutchinson et al. found an association between female sex and recurrence according to their Cox hazards regression analysis where Hazard ratio = 5.42, 95% confidence interval (CI) [1.2-24], and P=0.025.[22] No significant association was demonstrated in all other studies.[7-11,17,18,21,23-25]

BMI:

Eight studies analyzed BMI as a predictor.[7,8,11,17,18,21,23,25] Camp et al. evaluated BMI categorically as either obesity (BMI 30-40) or morbid obesity (BMI 40+), finding an association with both obesity (odds ratio (OR): 1.25, 95% CI: [1.03-1.51], P = 0.022) and morbid obesity (OR: 1.25, 95% CI: [1.01-1.55]. P= 0.044) on recurrence.[8] The other seven studies analyzed BMI as a continuous variable, finding that BMI was not a significant predictor.[7,11,17,18,21,23,25]

Diabetes status:

Eleven studies analyzed diabetes status as a predictor.[7-9,11,17,18,21-25] Two studies identified diabetes as having a significant association. Camp et al. found OR: 1.27, 95% CI: [1.07-1.51], and P = 0.011 according to their multivariate logistic regression, while Izadpanah et al. performed a Chi-square or Fisher's exact test and found a P-value of 0.002, which was significant with respect to their threshold of P < 0.5.[8,9] All other studies found that diabetes was not a significant risk factor.[7,11,17,18,21-25]

Race/Ethnicity:

Three studies evaluated race as a potential predictor. Still, none demonstrated a significant correlation according to their thresholds for statistical significance.[10,17,21] These analyses varied in comparison groups (type of race or ethnicity).

Concurrent surgery on the ipsilateral extremity:

Five studies examined whether concurrent surgery affects recurrence.[10,11,17,18,21] Three studies examined this dichotomously.[17,18,21] The remaining two examined associations with specific procedures, like carpal tunnel release.[10,11] In their multivariate logistic regressions, Schloemann et al. found that the risk of revision surgery was lower with a concomitant carpal tunnel release (OR: 0.66, 95% CI [0.44 - 0.98]; P = 0.04), and Krogue et al. similarly demonstrated a low risk of revision when any concomitant procedure was performed (OR: 0.19; 95% CI [0.08-0.46]; P < .01).[10,17]

Tobacco use:

Eight studies studied tobacco use as a predictor.[7,8,11,17,18,21,23,24] Two studies analyzed tobacco usage as a dichotomous outcome and did not establish a significant association.[11,18] Another two studies stratified smoking behaviors into "current," "former," and "never," finding no significant association.[7,21] Three more studies first conducted a univariate analysis but did not include this in the final regression model due to low statistical signifiance.[17,23,24] Only Camp et al. demonstrated a positive association between tobacco use risk of recurrence/revision (OR: 1.98; 95% CI [1.53-2.56]; P < 0.001).[8]

Preoperative Severity:

Seven studies examined preoperative severity as a risk factor.[9,11,17,20,21,23,25] All studies defined preoperative severity by the modified McGowan classification system. Kong et al. dichotomously assigned patients to a severe (III) or non-severe group (I and II) based on McGowan score, and confirmed a significant association on both bivariate analysis and multivariate regression (OR: 3.06, 95% CI [2.16–4.32], P <0.001).[23] The other six studies stratified amongst each grade of the McGowan criteria.[9,11,17,20,21,25] Of these, Gökay et al. and Suzuki et al. also found that preoperative severity was a significant predictor based on their thresholds for statistical significance.[20,25]

Surgical technique:

Six studies compared at least two different surgical techniques.[7,9,10,19,22,25] These comparisons varied widely, as some evaluated broadly between CuTR and UNT, while other studies compared subtypes. None of the studies focused on IMAT, and all other procedures, such as medial epicondylectomy, were excluded. Only two studies calculated a significant difference: Schloemann et al. found a higher rate of revision with submuscular anterior transposition (SMAT) compared to CuTR based on their multivariate regression (OR: 2.82, 95% CI [1.35 to 5.89]; P = 0.006), and Hutchinson et al. found a higher rate of CuTR compared to subcutanous anterior transposition (SCAT), which was significant per their Cox hazard's ratio regression, where hazard ratio = 0.33, 95% CI [0.12-0.89], and P =0 .028.[10,22]

Smit et al. identified an initial association with surgery technique on univariate analysis, although this did not persist in their regression analysis.[7] Izadpanah et al. performed a power analysis and determined that their cohort was too small to calculate any significant difference.[9] Kim et al. compared both objective and subjective measures of symptom recurrence (such as disability of the arm shoulder and hand (DASH), visual analog scale (VAS), pinch strength, and two-point discrimination) following endoscopic in situ decompression (EISD) and open in situ decompression (OISD). There was no significant difference found between these outcomes, although EISD demonstrated a higher reoperation rate, and all the reoperated patients demonstrated ulnar nerve subluxation.[19] Suzuki et al. estimated no significant association on bivariate analysis and thus excluded this from their logistic regression.[25]

Discussion

This systematic review has several implications for surgical practice. Overall, revision rates were low across all surgical techniques. Younger age was described as a risk factor in ten studies, although one study identified older age as a predictive risk factor. In contrast, another study described it as a protective factor. Diabetes was described to increase the risk of recurrence in two studies, while sex, BMI, and smoking status showed inconsistent associations. Severe preoperative symptoms or the McGowan score were associated with poorer outcomes in two studies. Surgeons should continue to recognize that a patient's prognosis may reflect the intersection of multiple risk factors and weigh them when predicting outcomes.

Previous literature has explored an association between younger age and a more acute symptomatic presentation.[26] Some surgeons cite ulnar nerve instability in younger patients as an indication to perform transposition.[27] Further research is required to determine whether a significant association with younger age may reflect worse preoperative severity or ulnar nerve instability. On the other hand, Schloemann et al. and Tong et al. analyzed the impact of advanced age on recurrence, and found contradicting results, describing its role as a protective factor or risk factor, respectively.[10, 24] It is feasible that CuTS symptoms are additive with comorbidities that advanced age patients experience, such as diabetes mellitus, higher BMI, or socioeconomic distress.[28] These health issues may contribute to recurrent symptoms. Conversely, higher rates of health screenings in older individuals may lead to earlier detection and management, improving the severity of overall symptoms.

Previous cohorts have reported that the diagnosis of CuTS is predominantly male.[29] Interestingly, in this review, female sex was found as a potential predictor in only one of twelve studies. Hutchinson et al. speculated that this could be related to the laxity of female ligaments as well as the tendency for women to have a higher carrying angle for the elbow.[9] It is possible that a higher carrying angle increases the risk of ulnar nerve entrapment in occupations where the elbow is kept at high angles, like with musicians, laborers, or hairdressers. Further research may consider stratifying for higher carrying angle when comparing males and females.

BMI is often described as an indicator of prognosis following orthopedic surgical procedures, especially in the management of lower extremity arthritis, given the detrimental effects that increased weight loads have on joints. Molina and Morgan described obesity's correlation with increased inflammatory cytokines and poor vascularization of adipose tissues as a mechanism for worse prognosis in orthopedic procedures.[30] Interestingly, weight loss programs have not demonstrated a significant improvement in postoperative outcomes in other compressive upper extremity neuropathies like CTS.[31] This aligns with this review's findings, which identified only one study reporting increased risk of recurrence with advanced obesity.[8] However, it is possible that biomechanical stresses and altered metabolic activity would become more significant in the elbow, as it is a larger joint with more fat pads compared to the wrist. Future prospective cohort studies may consider estimating a specific BMI threshold to determine if a weight loss regimen would improve outcomes.

Two studies identified diabetes as a potential predictor but did not explore this in much detail. None of the studies analyzed hemoglobin A1c (hbA1c), which has been demonstrated as a reliable measure for glycemic control.[32] Current evidence regarding other orthopedic procedures, like spine surgery, suggests that HbA1c may be reliable in predicting postoperative outcomes and complications.[33] While individual surgeons may monitor HbA1c levels on patient follow-up, future prospective studies may be interested in systematically analyzing these levels.

The studies varied widely in reporting of race/ethnicity, which reflects the difficulty in using race as a biological construct, as there is no standardized method for reporting race.[34] Surgeons should avoid counseling candidates for surgery on their prospective outcomes based on race, and they should recall that reported patterns may reflect socioeconomic patterns rather than physiology.

Concurrent surgery emerged in two studies as a protective factor. Shulman et al. examined the pathophysiology behind multiple compressive neuropathies in individual patients. They postulate that compressive neuropathies like CTS have a higher prevalence in patients treated for CuTS with respect to the general population, so resulting symptoms may represent a global compressive neuropathy rather than independent diagnoses.[35] A global compressive neuropathy reflects a different pathophysiology compared to isolated CuTS and may explain improved outcomes with concomitant releases. Surgeons should continue to evaluate concomitant disorders when treating CuTS, and future research is needed to evaluate for a global compressive neuropathy.

Smoking was previously studied with respect to risk for wound dehiscence following CuTR in 1,401 patients, demonstrating no significant association.[36] In this review, tobacco use was demonstrated as a predictor in only one study. Although there was no specific mechanism proposed, it seems reasonable for surgeons to discourage smoking due to suspected impairment of wound healing.[37]

This review examined preoperative symptom severity per the McGowan classification as modified by Goldberg.[38] VanNest and Ilyas propose that subjective impressions following treatment of mild preoperative symptoms have an association with reoperation.[18] In this review, the three significant studies instead demonstrate that greater preoperative severity is more likely to cause a risk for revision. This may be related to the irreversible nature of axon recovery with an extended period of nontreatment. A greater time from initial axon injury to treatment increases the risk of axonal atrophy and loss of sensation/motor function.[39] To avoid irreversible damage, surgeons should emphasize the degenerative nature of compression and potentially irreversible loss of function to patients.

Four of the six studies examined demonstrated no significant difference between surgical techniques. Each technique varies significantly in its approach: OISD involves a direct incision over the cubital tunnel to decompress the ulnar nerve, whereas EISD is a minimally invasive procedure that uses a soft tissue endoscope to visualize and decompress the nerve.[40] There are three different approaches to UNT, each varying in the depth at which the ulnar nerve is relocated. In SCAT, the ulnar nerve is transposed anterior to the medial epicondyle, where it is secured with a fascial sling.[41] In IMAT, it is instead placed within the flexor-pronator mass.[42] In SMAT, the ulnar nerve is placed underneath the flexor-pronator mass.[43] This review attempted to comprehensively compare these subtypes; however, a trend could not be described as each study compared different techniques. The heterogeneity of the outcome measurements precluded quantitative synthesis and thus limited conclusions as to which procedure may be superior. Moreover, with respect to each study individually, any perceived associations may not be generalizable to the

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overall population.

Current trends recommend CuTR as the primary procedure, reserving UNT for revisions or for patients with nerve subluxation, which can be assessed preoperatively or intraoperatively. The typical rationale for CuTR is that it offers a simpler and less invasive surgery than UNT while maintaining the native position of the nerve.[44] However, proponents of UNT state that CuTR fails to account for traction causing subluxation outside of the cubital tunnel, which was seen in the results of this review as well.[27,45] EISD is popular due to its minimal invasiveness, although it may not appropriately address ulnar nerve subluxation, as was demonstrated upon all reoperations in one cohort.[24,40] Differences between rates of recurrence/revision may be owed to institution or individual surgeon bias rather than the procedure itself. Future research exploring associations with risk factors should consider stratifying them by surgical technique.

This systematic review compared patients experiencing recurrence or requiring reoperation following surgical release with those who did not. However, our study does not distinguish between patients experiencing recurrence or reoperation. A weakness of this review was the marked heterogeneity between studies, with differences in the assessment of recurrence/reoperation, reported risk factors, and surgical techniques, methods for statistical analysis, as well as assessment of outcome and data presentation, which precluded meta-analysis. Additionally, given the limited discussion of effect sizes, it was impossible to perform separate analyses of individual risk factors or surgical techniques. Furthermore, there was significant variability between sample sizes in our reported studies, so our interpretations may favor studies with higher statistical power.

The scope of this review was limited to CuTR and UNT, but future research may explore other techniques to enhance the generalizability of these findings. This review selected a few risk factors, but further research should synthesize findings for other comorbidities. Additionally, the retrospective design of the included studies introduces the potential for selection bias as a source of error. The underpowered nature of some of these analyses also creates the risk of a Type II error, which may mask true associations.

To help translate these findings into clinical practice, we summarize key takeaways in the form of a clinical decision guide [Table 3]. These recommendations may assist surgeons in preoperative counseling, operative planning, and postoperative follow-up.

Table 3. Quick-Reference Clinical Pearls for Cubital Tunnel Release (CuTR)

Step	What to do	Rationale / Evidence
1. Default procedure	Offer cubital tunnel release (CuTR) as the initial operation.	Lowest reported revision rate; technically simple; preserves blood supply.
2. Check nerve stability	If the ulnar nerve subluxates intra-operatively or on dynamic exam, convert to ulnar nerve transposition (UNT) (subcutaneous for normal habitus, submuscular if scant soft-tissue cover).	UNT may lower the risk of persistent instability and symptomatic recurrence in these cases.
3. Flag higher-risk patients	• Age < 40 years • Severe neuropathy (McGowan grade III) • Revision setting (prior CuTR)	These factors show the most consistent association with recurrence or poorer outcome; use them to frame expectations.
4. Manage modifiable comorbidities	Screen and optimize diabetes, obesity, and smoking, although current evidence of impact is inconsistent.	Limited or conflicting data; optimization is prudent, but the benefit is unproven.
5. Consider concurrent CTR	If the patient also has symptomatic carpal tunnel syndrome, perform simultaneous carpal tunnel release.	One large database study showed lower revision odds when CTR was added.
6. Counsel with numbers	Typical revision rates in modern series: CuTR ≈ 2 – 4 %, UNT ≈ 5 – 8 %; risk may double in young or grade III patients.	Gives patients concrete figures for shared decision-making.
7. Early follow-up focus	At 2–6 weeks, confirm: • resolution or progression of numbness • wound healing and nerve stability • need for hand therapy	Early identification of non-improvement may allow for timely imaging or revision.

Conclusion

Younger age emerged consistently as a predictor for poor outcomes following CuTR. It remains unclear whether CuTR or UNT is the superior technique. Revision rates were low overall, with few rates of complications, and surgical release continues to serve as a viable option for long-term relief. Inconsistencies seen in risk factor associations highlight the need for prospective, randomized controlled trials with standardized outcome measures to optimize surgical decision-making based on individual patient presentation.

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Supplementary Material 1

PUBMED SEARCH STRING:
(cubital tunnel OR "Cubital Tunnel Syndrome"[Mesh] OR ulnar neuropathy OR "Ulnar Nerve Compression Syndromes"[Mesh] OR "Ulnar Neuropathies"[Mesh]) AND (anterior transposition OR subcutaneous transposition OR submuscular transposition OR intramuscular transposition OR "Decompression, Surgical"[Mesh] OR "in situ decompression") AND ("Recovery of Function"[Mesh] OR "Reoperation"[Mesh] or revision OR recurrence OR risk factors OR "Risk Factors"[Mesh] OR "Recurrence"[Mesh] OR recalcitrant OR "Treatment Outcome" [Mesh] OR "Postoperative Complications" [Mesh]) AND (2009/1:2024/11[pdat])