

Patient-Related Risk Factors for Infection Following Ulnar Nerve Release at the Cubital Tunnel

An Analysis of 15,188 Cases

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Background: Although cubital tunnel release is a commonly performed orthopaedic procedure, the overall incidence of and independent risk factors for infection largely remain undefined in the current literature.

Purpose: To establish the rate of postoperative infection after isolated cubital tunnel release and define relevant patient-related risk factors.

Study Design: Case-control study; Level 3.

Methods: All Medicare-insured patients undergoing ulnar nerve decompression at the cubital tunnel from 2010 through 2012 were identified. A multivariate binomial logistic regression analysis was utilized to evaluate the impact of patient-related risk factors for postoperative infection.

Results: A total of 330 (2.17%) postoperative infections were identified in 15,188 cases. The majority (87%) were managed nonoperatively, while 13% required surgical debridement. The most significant risk factors for infection included hemodialysis use (odds ratio [OR], 2.47), chronic anemia (OR, 2.24), age <65 years (OR, 2.08), tobacco use (OR, 1.65), morbid obesity (OR, 1.53), inflammatory arthritis (OR, 1.43), depression (OR, 1.36), hyperlipidemia (OR, 1.33), male sex (OR, 1.32), and chronic lung disease (OR, 1.29).

Conclusion: The present study was adequately powered to determine numerous patient-related risk factors for infection following cubital tunnel release.

Keywords: ulnar nerve; cubital tunnel release; elbow; infection

Entrapment of the ulnar nerve at the cubital tunnel occurs in approximately 18 to 25 individuals per 100,000 each year,^{13,15} and this incidence continues to rise annually, particularly for patients in high-demand occupations and sporting activities.^{1,9,17,22} It is the most common form of nerve impingement at the elbow and, other than carpal tunnel syndrome, is the second-most frequently encountered compression neuropathy in the upper extremity.²³ The elbow is the most common site for ulnar neuropathy, owing to the superficial location of the nerve and the effects of ischemia and traction caused by the repetitive mechanical stress that occurs secondary to elbow flexion and extension.¹⁷ Conservative management of cubital tunnel syndrome typically involves physical/occupational therapy, splinting of the

elbow in extension, administration of nonsteroidal anti-inflammatory drugs, and occasionally corticosteroids.⁹ Surgery is generally indicated when noninvasive measures fail to mitigate symptoms.^{7,8} Surgical treatment of ulnar nerve entrapment has taken many forms, including decompression in situ, decompression with anterior transposition (subcutaneous, submuscular, or intramuscular), and, in rare cases, medial epicondylectomy. Although the debate continues regarding the optimal treatment strategy, in situ decompression has steadily gained favor in recent years because of a decrease in procedural complication rates as compared with transposition.^{1,18,22}

While cubital tunnel release is traditionally performed with open techniques, a recent review by Smeraglia et al²¹ suggested that endoscopic approaches may allow for a smaller incision, decreased dissection of soft tissues, less iatrogenic nerve injury (particularly to the medial antebrachial cutaneous nerve), and cosmetic superiority over

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open techniques. Despite this, endoscopic and open approaches to cubital tunnel release are associated with complications.^{3,12,21} Nerve subluxation, hematoma, thrombophlebitis, and superficial infection have been reported with endoscopic decompression,²¹ while postoperative hemorrhage, superficial and deep wound infection, dysesthetic scarring, and limited elbow extension are the most common complications cited with open procedures.³ Although cubital tunnel release is not typically associated with a high risk of adverse events, Menendez et al¹⁴ found that among 7 other hand surgical procedures, cubital tunnel release ranked highest (0.56% incidence) in postsurgical acute care visits for surgical site infections.

Risk factors for postoperative infection following open cubital tunnel release have not been thoroughly described in the current literature, partially because it is relatively uncommon. Existing reports generally do not contain large enough cohorts or adequate power to properly identify factors that increase the risk of infection following ulnar nerve decompression at the elbow. To better understand these variables, a relatively large patient population is required. Accordingly, the purposes of this work were to utilize a national patient database to (1) report basic demographics for patients undergoing ulnar nerve decompression at the cubital tunnel, (2) determine the incidence of postoperative infection, and (3) identify independent patient-specific variables that increase the risk for postoperative infection.

METHODS

Following exemption by our hospital's institutional review board, we used the PearlDiver Patient Records Database (<http://www.pearldiverinc.com>) to query the 100% Medicare Standard Analytic Files from 2010 to 2012 for patients in the United States (US) who underwent cubital tunnel release with Current Procedural Terminology (CPT) code 64718 (neuroplasty and/or transposition; ulnar nerve at elbow). Patients who underwent any concomitant procedures—including decompression of the ulnar nerve at locations other than the elbow, carpal tunnel release, concomitant arthroscopy or endoscopy, fracture fixation, arthroplasty, ligament repairs or reconstructions, and other wrist or hand surgical procedures—were all excluded to obtain a final study cohort of patients with isolated open cubital tunnel release. Postoperative infections occurring within 90 days of surgery were identified with International Classification of Diseases, Ninth Revision (ICD-9) codes for diagnoses of postoperative infection or CPT codes for

TABLE 1

Procedure Codes at the Time of Initial Elbow Arthroscopy^a

CPT code used to identify patients undergoing open ulnar nerve decompression in the cubital tunnel

CPT-64718 Neuroplasty and/or transposition; ulnar nerve at elbow

CPT and ICD-9 codes used to identify postoperative infections within 90 d of cubital tunnel decompression

Procedure codes indicating surgical treatment of infection following cubital tunnel release

CPT-23930	Drainage of arm lesion
CPT-23931	Drainage of arm bursa
CPT-23935	Drainage of arm/elbow bursa
CPT-24000	Exploratory elbow surgery
CPT-10180	Complex drainage of wound
CPT-20005	Incision of deep abscess
ICD-9-P-86.22	Excisional debridement of wound, infection, or burn
ICD-9-P-86.28	Nonexcisional debridement of wound, infection, or burn

Diagnosis codes for infection

ICD-9-D-998.51	Infected postoperative seroma
ICD-9-D-998.59	Other postoperative infection
ICD-9-D-682.3	Cellulitis and abscess of upper arm and forearm
ICD-9-D-682.9	Cellulitis and abscess of unspecified sites
ICD-9-D-686.8	Other specified local infections of skin and subcutaneous tissue
ICD-9-D-711.02	Pyogenic arthritis involving upper arm
ICD-9-D-711.92	Unspecified infective arthritis involving upper arm
ICD-9-D-730.22	Unspecified osteomyelitis involving upper arm
ICD-9-D-730.92	Unspecified infection of upper arm bone

^aCPT, Current Procedural Terminology; ICD-9, International Classification of Diseases, Ninth Revision.

procedures for these indications (Table 1). Because many of the infection codes are not specific for the elbow, only procedures and diagnoses made within 90 days of the initial surgery were included. Cases with multiple codes for postoperative infection were considered single occurrences for the analysis. The study period was limited to the years 2010 through 2012 because the primary ICD-9 codes for postoperative infection were introduced in 2010 and the Medicare Standard Analytic Files currently include patients through only the 2012 calendar year in the PearlDiver system.

In addition to surgical volume and incidence of postoperative infection, the treatment rendered for each

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Ethical approval for this study was waived by the University of Virginia Institutional Review Board for Health Sciences Research.

TABLE 2
Patient Demographics and Procedure Codes at the Time of Initial Elbow Arthroscopy

	Patients, n (%)
Sex	
Male	7648 (50)
Female	7540 (50)
Age, y	
<65	6483 (43)
65-69	3559 (23)
70-74	2460 (16)
75-79	1515 (10)
80-84	802 (5)
≥85	369 (2)
Region of the United States	
Midwest	4662 (31)
Northeast	2637 (17)
South	5924 (39)
West	1965 (13)

postoperative infection (operative or nonoperative) was identified. Patient demographics included age, sex, body mass index, and tobacco usage. Based on ICD-9 codes, the following medical comorbidities were identified: alcohol abuse, diabetes mellitus, inflammatory arthritis, hypercoagulable disorder, hyperlipidemia, hypertension, peripheral vascular disease, congestive heart failure, coronary artery disease, chronic lung disease, chronic liver disease, chronic kidney disease, use of hemodialysis, chronic anemia, thyroid disease, and major depression.

Statistical Analysis

To determine the independent adjusted odds ratio (OR) for the risk of postoperative infection for each patient demographic and medical comorbidity studied, a multivariate binomial logistic regression analysis was utilized. This analytic method was chosen because it permits independent assessment of each risk factor while controlling for all other variables inserted into the model; 95% CIs and P values are provided for all ORs. The trends in overall surgical volume and the number of postoperative infections over the course of the study period were analyzed with linear regression, and the corresponding R² values are provided. Infection rates and proportions of postoperative infections treated surgically versus nonsurgically were compared among years with chi-square analysis. The threshold for statistical significance was set to P < .05.

RESULTS

During the course of the study period, 15,188 patients underwent isolated ulnar nerve decompression at the cubital tunnel, with an overall incidence of 18.7 surgical procedures per 100,000 insured. There were similar proportions between male (n = 7648, 50.4%) and female (n = 7540, 49.6%) patients (Table 2). The most common age group represented patients <65 years (n = 6483, 43%), followed by those aged

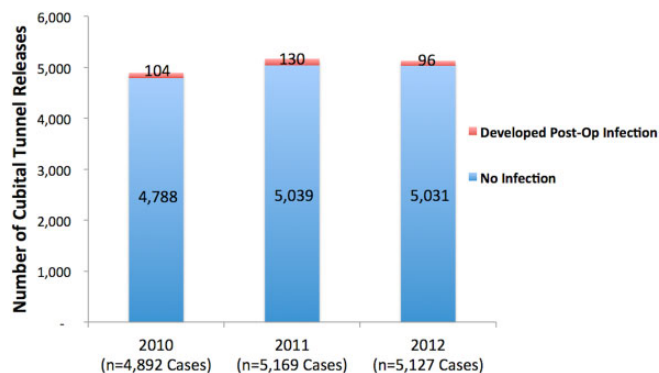


Figure 1. Annual number of open cubital tunnel releases performed in the United States Medicare population.

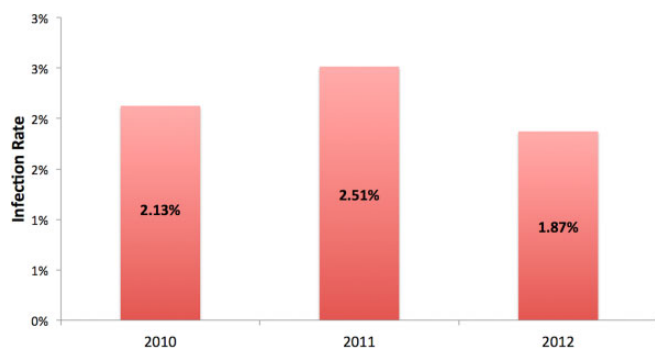


Figure 2. Postoperative infection rate for patients undergoing cubital tunnel decompression.

65 to 69 years (n = 3559, 23%). For comparative purposes, during this same period, 19.9% of all Medicare patients were <65 years old. Procedures were performed with geographic diversity, with the highest number in the South (n = 5924; 39% of cases; incidence of 19.0 per 100,000 insured), followed by the Midwest (n = 4662; 31%; 21.9 per 100,000), Northeast (n = 2637; 17%; 17.2 per 100,000), and the West (n = 1965; 13%; 14.6 per 100,000).

The total number of ulnar nerve decompressions at the cubital tunnel did not change significantly over time (R² = 0.620, P = .423), ranging from a low of 4892 in 2010 to a high of 5169 in 2011 (Figure 1). Similarly, the number of postoperative infections was similar from year to year (R² = 0.051, P = .856). The overall infection rate was 2.17% (330 infections in 15,188 cases), which remained steady from 2010 to 2012 (range, 1.87%-2.51%) (Figure 2). For the 330 patients who developed a postoperative infection, 42 (12.7%) were treated surgically, and the remaining 288 (87.3%) were treated nonoperatively (Figure 3). There were no significant differences in the proportion of infections that required surgical treatment from year to year (P = .791).

A number of variables analyzed demonstrated a significant association with postoperative surgical site infection, and these are listed in Table 3 with their corresponding ORs, 95% CIs, and P values. The factors that carried the greatest risk of infection were as follows: hemodialysis use

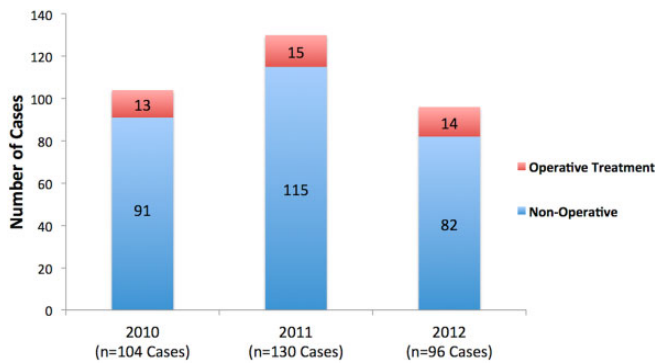


Figure 3. Treatment rendered for patients developing post-operative infection.

TABLE 3
Significant Risk Factors for Infection
Following Open Cubital Tunnel Release

Variable	Odds Ratio	95% CI	P
Demographics			
Age <65 y	2.08	1.52-2.85	<.001
Tobacco use	1.65	1.31-2.07	<.001
Body mass index			
30-40 (obesity)	1.52	1.18-1.94	<.001
≥40 (morbid obesity)	1.53	1.16-2.01	.002
Male sex	1.32	1.07-1.63	.008
Comorbidity			
Hemodialysis use	2.47	1.19-5.16	.016
Chronic anemia	2.24	1.72-2.90	<.001
Inflammatory arthritis	1.43	1.08-1.88	.012
Depression	1.36	1.09-1.70	.007
Hyperlipidemia	1.33	1.00-1.76	.049
Chronic lung disease	1.29	1.04-1.60	.022

(OR, 2.47; 95% CI, 1.19-5.16; $P = .016$), chronic anemia (OR, 2.24; 95% CI, 1.72-2.90; $P < .001$), age <65 years (OR, 2.08; 95% CI, 1.52-2.85; $P < .001$), tobacco use (OR, 1.65; 95% CI, 1.31-2.07; $P < .001$), and morbid obesity (OR, 1.53; 95% CI, 1.16-2.01; $P = .002$). In contrast, many of the comorbidities did not increase the risk of infection, and these are listed in Table 4.

DISCUSSION

The cubital tunnel is the most common site of compression of the ulnar nerve, and as such, cubital tunnel release is one of the most commonly performed surgical procedures about the elbow. Although the incidence of postoperative infection has been reported in small, single-institution case series, its uncommon occurrence has made identification of independent risk factors for infection difficult thus far. Accordingly, the purpose of this study was to analyze a large national cohort of patients undergoing ulnar nerve decompression at the elbow to define general patient demographics, recent trends in procedural rates, the incidence of postoperative infection, and patient-specific factors that

TABLE 4
Factors Not Increasing the Risk for Infection
Following Open Cubital Tunnel Release

Variable	Odds Ratio	95% CI	P
Demographics			
Low body mass index (<19)	0.97	0.31-3.07	.962
Comorbidity			
Hypercoagulable state	1.16	0.78-1.72	.459
Alcohol abuse	1.12	0.83-1.50	.468
Diabetes mellitus	1.08	0.87-1.34	.507
Chronic kidney disease	1.06	0.81-1.40	.675
Peripheral vascular disease	1.06	0.82-1.39	.648
Hypothyroidism	1.05	0.84-1.31	.668
Hypertension	1.03	0.75-1.41	.852
Chronic liver disease	1.01	0.75-1.36	.942
Congestive heart failure	0.82	0.63-1.08	.159
Coronary artery disease	0.77	0.61-0.97	.011

confer an increased risk of developing infection within 90 days of surgery. In the US Medicare population, the overall rate of postoperative infection following open cubital tunnel decompression is relatively low at 2.17%; however, a number of patient-specific factors significantly increased this risk: hemodialysis use, chronic anemia, age <65 years, tobacco use, and obesity.

The demographics of patients undergoing ulnar nerve decompression at the cubital tunnel in this study is similar to those of other published works on this topic.^{1,22} Although the overall number of procedures did not increase over the 3-year period, other authors identified rising rates when analyzing trends over at least 8 years.^{1,22} When examining cubital tunnel decompressions performed from 1996 to 2006, Soltani et al²² determined that the annual number of procedures nearly doubled during that span. They also concluded that the proportion of cases with ulnar nerve transposition declined significantly during the study. Similarly, Adkinson et al¹ reported a decline in ulnar nerve transposition rates from 27% in 2005 to 9% in 2012. These studies represent 2 of the largest reports ever published on ulnar nerve decompression at the elbow. Although they greatly advanced our understanding of this commonly occurring clinical entity, an analysis of infection rates and risk factors for infection was not performed in either study.

To date, our understanding of the postoperative complications related to decompression of the ulnar nerve at the cubital tunnel are quite limited, and this is particularly true for infection. A few studies focused on neurologic complications, iatrogenic injuries, and outcomes of revision surgery; however, a true understanding of the incidence of infection is lacking.^{2,10,16,19,20} The studies reporting on infections are generally limited to single-institution series with small patient numbers.^{3,4,11,12} In these reports, postoperative infection rates ranged from 0.4% to 6.8%. This variability may be due to the relatively low sample sizes for these studies. Unfortunately, none of these studies reported on independent patient-specific risk factors for infection. In a prospective randomized trial of in situ decompression versus anterior transposition, Biggs and Curtis⁴ observed an

increased incidence of infection when the nerve was transposed (3 of 23; 13%) as opposed to when it was decompressed in situ (0 of 21; 0%), but the conclusions were limited by the small sample size. When compared with other common hand and elbow surgical procedures, cubital tunnel surgery was the most common location for surgical site infections requiring presentation to an acute care setting.¹⁴

In the current study, the overall rate of postoperative infection was 2.17%, and the majority of these patients were treated nonoperatively (87%) rather than surgically (13%). Although the overall rate of infection was low, the odds of infection were significantly increased by a number of patient-specific factors. Of these, the variables that conferred the highest risk of infection included hemodialysis use (OR, 2.47), chronic anemia (OR, 2.24), age <65 years (OR, 2.08), tobacco usage (OR, 1.65), and morbid obesity (OR, 1.53). Although most of these risk factors are well established and mirror findings from studies of surgical site infections in other regions,^{5,6,24} the relationship of younger age and higher infection rate may not be as intuitive. Although this study utilized a cohort of Medicare-insured patients, a number of patients were <65 years old at the time of surgery. It is worth noting that the most common methods in which persons aged <65 years qualify for Medicare insurance include having received disability insurance for ≥ 24 consecutive months or a diagnosis of end-stage renal disease. Therefore, although highly significant for the Medicare population, this increased infection risk for younger patients may not always apply to the non-Medicare patient population, as there is a predisposed selection bias toward patients with significant medical comorbidities in this younger subpopulation.

Although this work represents a novel contribution to our understanding of infection following cubital tunnel surgery, it is certainly not without limitations. A number of these are inherent to utilization of a national patient database: the potential for miscoding by practitioners, utilization of nonspecific infection codes, and lack of sufficient detail to make conclusions about optimal treatment strategies. To limit the influence of nonspecific codes (ie, those that do not specify the location of the infection), only infections occurring within 90 days of an isolated cubital tunnel release were included to maximize the likelihood that the infection was related to the surgical procedure of interest. It is also worth noting that although all procedures containing CPT codes for arthroscopy or endoscopy were excluded, some endoscopic releases may have inadvertently been included if they were not initially accompanied by endoscopic/arthroscopic codes.

Another limitation of the study is that the study population was a sample of opportunity; thus, no additional patients could be added to improve statistical power. While some statistically significant findings were appreciated, it is likely that the study group was not sufficiently large to adequately statistically power every endpoint or risk factor. A third limitation is that in situ decompression and nerve transposition are represented by a single CPT code and could not be distinguished from each other in this work. Although recent studies have indicated that the rate of ulnar nerve transposition is decreasing as in situ

decompression continues to gain popularity,¹ the precise number of transpositions included in this study remains unknown. Finally, as mentioned, this study analyzed cases in the Medicare-insured population, which may not always be representative of the entire US population. Despite these limitations, this study has a number of strengths: inclusion of >15,000 patients, analysis of a multitude of demographics and comorbidities, study of a recent time frame that is most likely to represent modern surgical techniques, utilization of multivariate regression modeling to control for confounders, and report of a number of previously unknown findings.

CONCLUSION

While decompression of the ulnar nerve at the cubital tunnel of the elbow is a commonly performed procedure, postoperative infections are uncommon, occurring in approximately 2.17% of Medicare cases. The majority of these are treated nonoperatively; however, 13% of cases require surgical debridement to eliminate infection. A number of patient-specific factors are independently associated with an increased risk of postoperative infection, including hemodialysis use, chronic anemia, age <65 years, tobacco use, obesity, inflammatory arthritis, depression, hyperlipidemia, male sex, and chronic lung disease. Although this does not necessarily preclude these patients from undergoing surgery, these data can be used to better inform them of the associated risks of postoperative infection.

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