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Surgical Treatment of Cubital Tunnel Syndrome: Trends and the Influence of Patient and Surgeon Characteristics

Joshua M. Adkinson, MD[1], **Lin Zhong, MD, MPH**[2], **Oluseyi Aliu, MD, MS**[3], and **Kevin C. Chung, MD, MS**[4]

[1]Assistant Professor of Surgery, Division of Plastic Surgery, Ann and Robert H. Lurie Children's Hospital of Chicago. 225 E. Chicago Ave, Box 93, Chicago, IL 60611

[2]Clinical Research Coordinator, Department of Surgery, Section of Plastic Surgery, University of Michigan Health System. Same address to the corresponding author

[3]Resident, Department of Surgery, Section of Plastic Surgery, University of Michigan Health System. Same address to the corresponding author

[4]Professor of Surgery, Department of Surgery, Section of Plastic Surgery, Assistant Dean for Faculty Affairs, University of Michigan Health System

Abstract

Purpose—Cubital tunnel syndrome is the second most common compression neuropathy in the upper extremity. A variety of procedures are used for treatment of cubital tunnel syndrome. There is a lack of consensus regarding the most appropriate procedure owing to similar rates of operative success and strong proponents for each technique. Our aim was to examine trends in and determinants of the use of different procedures for treatment of cubital tunnel syndrome.

Methods—We performed a retrospective cross-sectional analysis of the Healthcare Cost and Utilization Project Florida State Ambulatory Surgery Database for 2005 to 2012. We selected all patients who underwent in-situ decompression, transposition, or other surgical treatments for cubital tunnel syndrome. We tested trends in the use of these techniques and performed a multivariable analysis to examine associations between patient characteristics and surgeon case volume and the use of different techniques.

Results—Of the 26,164 patients who underwent surgery for cubital tunnel syndrome, 79.7% underwent in-situ decompression, 16.2% underwent transposition, and 4.1% underwent other surgical treatment. Over the study period, there was a statistically significant increase in the use of in-situ release and a decrease in the use of transposition. Females and patients treated by surgeons with a higher cubital tunnel surgery case volume underwent in-situ release at a statistically higher rate than other techniques.

Conclusions—In Florida, surgeon practice reflects the widespread adoption of in-situ release as the primary treatment for cubital tunnel syndrome and these numbers are increasing. Patient demographics and surgeon-level factors influence procedure selection.

Corresponding Author: Kevin C. Chung, MD, MS, Section of Plastic Surgery, University of Michigan Health System, 2130 Taubman Center, SPC 5340, 1500 E. Medical Center Drive, Ann Arbor, MI, 48109-5340, kecchung@umich.edu, Phone 734-936-5885, Fax 734-763-5354.

Level of Evidence—III, Therapeutic

Keywords

cubital tunnel syndrome; surgeon volume; in-situ decompression; ulnar nerve transposition; medial epicondylectomy

Introduction

Ulnar nerve entrapment at the elbow is the second most common compression neuropathy in the upper extremity (1, 2). The incidence is estimated at 25 cases per 100,000 person-years (3, 4), affecting men twice as frequently as women (5). In many patients, the progressive disability resulting from ongoing pain, paresthesias, and muscle weakness (6-10) has a considerable economic impact. Juratli et al. (11) found that nearly half of all workers with ulnar neuropathy at the elbow were receiving disability benefits prior to their official diagnosis. Cubital tunnel syndrome, therefore, has important functional and financial implications for patients.

A variety of surgical approaches are used for the treatment of cubital tunnel syndrome. These include in-situ decompression, nerve transposition techniques, and other techniques such as medial epicondylectomy (2, 12, 13). There is disagreement in the literature regarding the most commonly used method of treatment for cubital tunnel syndrome (5, 14-16). Furthermore, recent literature has shown no difference in treatment effectiveness between in-situ decompression and transposition, although fewer complications have been reported after in-situ decompression (17-30). These findings underscore the challenges associated with selecting the most appropriate procedure for cubital tunnel syndrome treatment.

A survey by Hagemen et al. (31) demonstrated that surgeons in the U.S. rely on “what works in my hands”, “familiarity with treatment”, or “what my mentor taught me” when faced with inconclusive evidence. The choice of operative treatment continues to be largely based on the surgeon's preference and experience (32-34). In this study, we sought to evaluate trends in and associations with the use of different surgical techniques for management of cubital tunnel syndrome. We hypothesize that socio-demographic patient factors and surgeon case volume will be significantly associated with the use of specific surgical techniques for treatment of cubital tunnel syndrome.

Materials and Methods

Data Source

We performed a cross-sectional analysis of the Agency for Healthcare Research and Quality (AHRQ) Healthcare Cost and Utilization Project (HCUP) Florida State Ambulatory Surgery Database (SASD) for the years 2005 to 2012. The database contains all-payer, discharge-level records for all ambulatory procedures occurring in emergency departments, hospital-based surgical units, and freestanding ambulatory surgery centers statewide. Although participating health organizations control the release of specific data, the database represents 100% of the records processed by AHRQ. Data are confirmed to be valid, internally consistent, and consistent with norms, when feasible. An independent contractor reviews all

database statistics to ensure compatibility for closely related data elements, such as diagnosis and procedure codes (35).

Whereas treatment trends were described using 2005-2012 data, patient and surgeon-level analyses were performed using data from 2010-2012 because they were the most recent data available that permitted consistently accurate assignation of patients to the surgeons who treated them. The database is publicly available and de-identified. As such, our study was exempt from human subject's regulation by the Institutional Review Board.

Cohort Selection

We included patients age 18 years and older who underwent surgical treatment for cubital tunnel syndrome and excluded patients with a non-Florida ZIP code, an unidentifiable treating surgeon, or a concomitant upper extremity fracture (ICD-9 codes 812.xx and 813.xx). We defined our study population using International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9 CM) diagnostic code 354.2 (cubital tunnel syndrome). The current ICD coding system has different treatment codes for procedures used in the surgical treatment of compression of the ulnar nerve at the elbow. The codes 04.49 and 04.04 indicate simple decompression of the ulnar nerve at the elbow, code 04.60 indicates transposition of the ulnar nerve at the elbow, and code 04.79 indicates surgical treatment of cubital tunnel syndrome by other methods. These diagnosis and treatment codes were verified by 2 members of our research staff (JA, LZ). Patients without ICD-9 procedure codes were assumed to have not undergone surgery for cubital tunnel syndrome and were excluded from the analyses. Patients were assigned to one of 3 groups: in-situ release, transposition, and other treatment. Our final study cohort included 26,164 patients for the test of time trend of use for different procedures (2005-2012 cohort) and 11,460 patients (2010-2012 cohort) for the analysis of factors associated with procedure selection. The process of cohort creation is displayed in Figure 1.

Study Variables

Our primary outcome was the method of surgical treatment for cubital tunnel syndrome. Patient socio-demographic variables included age, sex, race (white, black, and other), household income, and location of patient residence. Household income was derived using patient ZIP code as a proxy and patient residence was sub-classified into large metropolitan, small metropolitan, micropolitan, and other as assigned by the HCUP SASD. Health-system-related variables, such as third-party payer (Medicare, Medicaid, Private, other) status were also included in the analysis. Surgeon factors included total volume and type of procedures used for treatment of cubital tunnel syndrome between 2010 and 2012.

Statistical Analysis

We used descriptive statistics to summarize trends in surgical management of cubital tunnel syndrome in the state of Florida from 2005 to 2012. We performed simple linear regressions using the rate of each type of procedure per year as the outcome and the calendar year as the key predictor. Using data from 2010 and 2012, we performed a univariate analysis to examine the association between patient/surgeon characteristics and the surgical technique. We then performed a hierarchical logistic regression analysis to examine the influence of

patient characteristics on the choice of procedure for cubital tunnel syndrome with a binary dependent variable (in-situ release vs. transposition/other treatment). We assigned in-situ release as the reference group because it was the most commonly used technique. The selection of covariates (patient characteristics and surgeon volume/technique variety) in the multivariable model was based on results from the univariate analysis. To control for correlation among procedures performed by each surgeon, we included each surgeon as a random intercept of the model. Lastly, we calculated the intraclass correlation coefficient to ascertain the extent to which surgical treatment may be ascribed to clustering under a particular surgeon's care.

Results

Of the 2005-2012 study cohort (26,164 patients) who underwent surgery for cubital tunnel syndrome, 20,836 underwent in-situ decompression (79.7%), 4,247 underwent transposition (16.2%), and 1,081 underwent other surgical treatment (4.1%). Over the study period, there was a significant increase in the use of in-situ release and a decrease in the use of transposition techniques (Figure 2). For example, in 2005, the proportion of in-situ release among all techniques was 70%; this proportion increased by 26% over the study period. The proportion of transposition technique in 2005 was 27%; this proportion decreased 67% by 2012. On average, the proportion of in-situ release among other procedures increased 2.9% each year (95% CI [2.4%, 3.4%]) ($p<0.001$) and the proportion of transposition decreased 2.8% each year (95% CI [2.4%, 3.2%]) ($p<0.001$) (Table 1).

Patient characteristics and procedure selection

For the 2010-2012 study cohort, socio-demographic and clinical characteristics of patients undergoing each procedure are presented in Table 2. No statistically significant association was found with regard to age, race, and median household income quartile on the selection of treatment techniques in univariate analysis. Women were slightly more likely than men to undergo in-situ release ($p<0.001$). Statistically significant differences were found with regard to patient locations and primary payers between the three procedure categories (Table 2).

Surgeon characteristics and procedure selection

In univariate analysis, both surgeon characteristics (case volume and number of types of procedure performed) were significantly associated with the procedure selected for treatment of cubital tunnel syndrome. Of the 713 surgeons who performed cubital tunnel release between 2010 and 2012, 63% performed only one technique (Table 3). Most of the surgeons (95%) performed one or two procedure types.

Multivariable analysis of factors associated with in-situ release

In multivariable analysis, males were less likely to undergo in-situ release than female patients (OR=0.81, 95%CI [0.70, 0.93]) ($p=0.004$). In addition, patients with private insurance were less likely to undergo in-situ release than Medicare beneficiaries (OR=0.65, 95% CI [0.45, 0.93]) ($p=0.02$) (Table 4). Patient location was not associated with the use of in-situ release.

Patients of surgeons in the highest category of case volume were substantially more likely to undergo in-situ release as compared to other techniques (OR=59.81, 95% CI [16.37, 218.56]) ($p<0.001$). Patients of surgeons who performed more than one type of procedure for cubital tunnel syndrome were less likely to undergo in-situ release ($p<0.001$) (Table 4). The intraclass correlation coefficient among surgeons in the sample was 0.67.

Discussion

In this cross-sectional study of recent patterns of treatment for cubital tunnel syndrome in the state of Florida, our results show that in-situ release is the most commonly used procedure, with a significant year over year increase in use over the study period. These findings are consistent with a study by Soltani et al. using the 1994, 1996, and 2006 National Survey of Ambulatory Surgery databases (5). They found that in-situ decompression replaced transposition as the technique most frequently performed for cubital tunnel syndrome in 2006. In their study, however, transposition techniques still comprised 38% of all surgical procedures used for treatment. We found that transposition encompassed only 16.2% of all procedures performed between 2005 and 2012. This discrepancy may be attributable to the more recent data collection period and our focus on only one state (Florida).

Of the variables assessed in this study, surgeon case volume was the factor most strongly associated with the use of a particular procedure. Specifically, we found that surgeons with the highest volume of cubital tunnel syndrome cases were significantly more likely to use in-situ release. One may surmise that surgeons with a high volume of cubital tunnel syndrome patients would be increasingly aware of the expanding role and established effectiveness of in-situ release. Further, a high intraclass correlation coefficient was found among encounters for the same surgeon. This indicates that the procedure a patient undergoes is highly dependent upon the treating surgeon. This finding was also noted in another Florida HCUP study evaluating patterns of treatment for thumb carpometacarpal arthritis (32). In both studies, effect sizes for surgeon-level characteristics greatly outweighed those for patient-level characteristics.

We also found that men were significantly less likely to undergo in-situ release as compared to transposition or other techniques. Richardson et al. (36) proposed that men may develop greater pressures over the ulnar nerve with hand usage as compared to females. This finding may partially explain the higher rates of transposition in men because greater pressure over the nerve is presumed to cause more profound neuropathy (37), thus theoretically providing the impetus to proceed with transposition or epicondylectomy.

Our study has several limitations due to the data source and the retrospective nature of the study. The quality of administrative datasets cannot be thoroughly confirmed and missing data remains an issue. For example, 24% of all patients in the Florida SASD database with a cubital tunnel syndrome diagnosis had no assigned ICD-9 procedure code. Although this cohort likely did not undergo surgical intervention for cubital tunnel syndrome, it is theoretically possible that the procedure code was not abstracted into the database. Importantly, secondary analysis found no clinically relevant differences in socio-

demographics between this subgroup and patients with an ICD-9 procedure code. Further, no other surgeon-related variables, such as age, primary specialty, fellowship training, or years in practice, were available with the Florida SASD database. Because we are using data from only one state, our results may not be representative of treatment throughout the United States. Previous studies have shown geographical variation in the treatment of various hand conditions (38-40) and this may also be true of treatment of cubital tunnel syndrome. However, the trends we found regarding the increasing use of in-situ release are similar to those shown in other population-level studies on the treatment of cubital tunnel syndrome (5).

Because the Florida SASD surgeon identification number assignation changed between 2009 and 2010, we could only longitudinally track treatment choices by individual surgeon from either 2005 to 2009 or 2010 to 2012; we selected 2010 to 2012 because they were the most recent data. This narrow timeframe limited our ability to longitudinally analyze substantial changes in physician practice. Lastly, it is possible that some patients may have undergone revision ulnar nerve surgery with a different technique, which may account for some of the variation seen in treatment choices. Our data was cross-sectional with no longitudinal patient tracking and there is no diagnosis code for recurrent cubital tunnel syndrome to categorize this subset of patients. However, assuming a low rate of revision surgery, <7% as demonstrated by Goldfarb et al. (41) and the dominance of surgeon factors (ICC of 0.67), including revision surgery as another independent variable would not significantly change our study findings.

Contemporary healthcare mandates require increasing justification for resources. As a result, hand surgeons must support surgical decision-making with the best available evidence. Although much has been written about the established difficulty of influencing surgical practice with best-practice guidelines (42, 43), our analysis reveals the widespread adoption of in-situ release for treatment of cubital tunnel syndrome in Florida and these numbers are increasing. As with most procedures, however, patient demographics and surgeon-level factors influence procedure selection.

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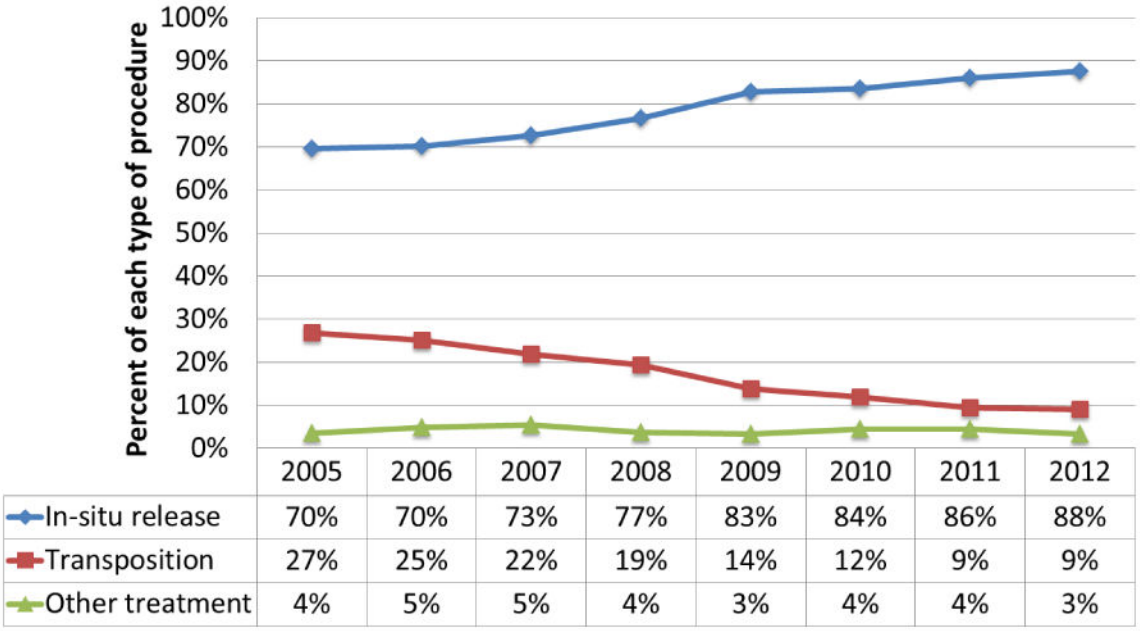
Figure 1. The establishment of the study cohort



	2005	2006	2007	2008	2009	2010	2011	2012
In-situ release	70%	70%	73%	77%	83%	84%	86%	88%
Transposition	27%	25%	22%	19%	14%	12%	9%	9%
Other treatment	4%	5%	5%	4%	3%	4%	4%	3%

Figure 2. Trends in the use of each procedure type between 2005 and 2012

Table 1

Time trend of each type of cubital tunnel syndrome surgical treatment (2005-2012)

	Average change in percent each year[¥]	P value
In-situ release	2.9 (2.4, 3.4)	<0.001
Transposition	-2.8 (-2.4, -3.2)	<0.001
Other treatment	-0.1 (-0.1, 0.3)	0.52

[¥]The average change in the rate of each type of procedure was beta-coefficient calculated from a simple linear regression model.

Table 2
Characteristics of the patient cohort by types of surgical procedures (2010-2012)

	In-Situ Release	Transposition	Other treatment
Patient cohort			
No. of patients	9833 (86%)	1161 (10%)	466 (4%)
Age			
Younger than 44	1753 (18%)	236 (20%)	91 (20%)
45 to 54	2445 (25%)	254 (22%)	115 (25%)
55 to 65	2757 (28%)	341 (29%)	112 (24%)
Greater than 65	2878 (29%)	330 (28%)	148 (32%)
Sex *			
Male	4730 (48%)	627 (54%)	258 (55%)
Female	5097 (52%)	533 (46%)	208 (45%)
Missing	6 (0%)	1 (0%)	0 (0%)
Race			
White	7614 (77%)	994 (86%)	305 (65%)
Black	843 (9%)	83 (7%)	39 (8%)
Other	1228 (12%)	74 (6%)	119 (26%)
Missing	148 (2%)	10 (1%)	3 (1%)
Patient location *			
Large metro	4957 (50%)	488 (42%)	264 (57%)
Small metro	4043 (41%)	568 (49%)	182 (39%)
Micro	482 (5%)	71 (6%)	15 (3%)
Other	351 (4%)	34 (3%)	5 (1%)
Median household income			
Quartile 1	2342 (24%)	248 (21%)	93 (20%)
Quartile 2	2341 (24%)	337 (29%)	105 (23%)
Quartile 3	2585 (26%)	307 (26%)	148 (32%)
Quartile 4	2362 (24%)	248 (21%)	110 (24%)
Missing	203 (2%)	21 (2%)	10 (2%)
Primary Payer *			
Medicare	3497 (36%)	459 (40%)	171 (37%)
Medicaid	416 (4%)	67 (6%)	10 (2%)
Private	4722 (48%)	504 (43%)	212 (45%)
Other	1198 (12%)	131 (11%)	73 (16%)

† Large metro, 1 million residents or more; small metro, less than 1 million residents; micro, adjacent to large or small metro; Other, not metro or micro

* P value <0.001, from Pearson's Chi-square test of independent distribution

Table 3
Characteristics of the surgeon cohort (2010-2012)

Surgeon characteristics	No. of Surgeons
No. of procedure types performed*	
One type	448(63%)
Two types	228(32%)
Three types	37(5%)
Case volume*	
Quartile 1 (1 case)	171(24%)
Quartile 2 (2-4 cases)	219(31%)
Quartile 3 (5-11 cases)	146(20%)
Quartile 4 (11-572 cases)	177(25%)

Table 4

Multivariable analysis of factors associated with the use of in-situ release for treatment of cubital tunnel syndrome (2010-2012)

Patient and surgeon characteristics	Adjusted Odds Ratio ¥	P value
Sex		
Female	1	-
Male	0.81 (0.70-0.93)	0.004
Patient location		
Large metro	1	-
Small metro	1.18 (0.69-2.01)	0.55
Micro	1.06 (0.65-1.74)	0.80
Other	1.12 (0.63-2.00)	0.70
Primary Payer		
Medicare	1	-
Medicaid	1.06 (0.90-1.24)	0.50
Private	0.65 (0.45-0.93)	0.02
Other	0.93 (0.74-1.18)	0.55
No. of procedure types performed by the surgeon between 2010 and 2012		
One type	1	
Two types	0.13 (0.09-0.19)	<.0001
Three types	0.07 (0.04-0.14)	<.0001
Surgeon case volume between 2010 and 2012†		
Quartile 1 (1-21 case)	1	
Quartile 2 (22-61 cases)	3.62 (2.25-5.82)	<.0001
Quartile 3 (62-195 cases)	20.83 (9.9-43.83)	<.0001
Quartile 4 (195-572 cases)	59.81 (16.37-218.56)	<.0001

Large metro, 1 million residents or more; small metro, less than 1 million residents; micro, adjacent to large or small metro; Other, not metro or micro

¥Adjusted odds ratios of undergoing in-situ release were calculated in hierarchical logistic models with a random effect of surgeons who treated the patient cohort, simultaneously adjusting for all patient factors.