Rates of Revision Surgery following In Situ Decompression versus Anterior Transposition for the Treatment of Idiopathic Cubital Tunnel Syndrome

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Abstract

Objective The current understanding of revision rates following surgery for the primary surgical treatment of idiopathic cubital tunnel syndrome (CuTS) remains unclear. The purpose of this study was to describe and compare the rate of revision surgery following in situ decompression (SD) versus anterior transposition (AT) after the surgical treatment of idiopathic CuTS and examine possible predicting variables for revision.

Materials and Methods A retrospective cohort study was performed at a single institution by querying records for all CuTS surgeries performed between January 2010 and December 2015. The initial query resulted in 1,967 cases. Exclusion criteria included acute trauma, concurrent unrelated primary elbow procedure, revision surgery, incomplete records, and age younger than 18 or older than 89 years. A total of 1,384 surgeries met criteria for study inclusion. A case-control study was then performed with 39 cases of revision and a group of 76 control cases that did not undergo revision surgery. Bivariate analysis followed by multivariate logistic regression was performed to evaluate predictors of revision.

Results Of the 1,384 procedures, 979 were SDs (70.7%) and 405 were ATs (29.3%). Among the 1,384 total procedures, there were 39 primary cubital tunnel surgeries resulting in a revision surgery (2.8%). The revision rate for SD was 3.1% and the revision rate for AT was 2.2%. Predictors of revision were younger age, increased nerve conduction velocity, and decreased duration of symptoms.

Conclusion In the surgical treatment of idiopathic CuTS, the overall revision rate is low (2.8%). This study found no significant difference in revision rate between SD and AT, but that risk for revision surgery overall was associated with younger age, increased nerve conduction velocity, and decreased duration of symptoms.

Level of Evidence This is a therapeutic, level III study.

Keywords

- cubital tunnel release
- ulnar nerve release
- ulnar nerve decompression
- transposition

Introduction

Cubital tunnel syndrome (CuTS) is the second most prevalent compressive neuropathy of the upper arm with ~30 cases per 100,000 people each year.¹ Ulnar nerve compression leads to pain and paresthesias in the fifth digit, medial portion of the fourth digit, and the corresponding area of the palm, as

well as weakness and atrophy primarily in the intrinsic and hypothenar muscles of the hand. While conservative treatment methods can be effective for relieving symptoms, ~42% of even mild cases of CuTS are refractory to conservative treatment methods, making surgery a common therapeutic intervention.² Broadly, there are two main surgical options that are employed to relieve pressure on the ulnar nerve, in

situ decompression (SD), and anterior transposition (AT). AT can be further divided into submuscular, intramuscular, and subcutaneous variations. Definitive indications for each procedure remain unclear. SD can be indicated for most cases of idiopathic CuTS without preoperative ulnar nerve instability and/or prior surgery. While AT can be used for idiopathic cases as well, AT is also used for cases with acute traumatic symptoms, nerve instability, triceps hypertrophy, deformity or lesions in the cubital tunnel, and recurrence of symptoms after prior decompression surgery. Otherwise, surgeon preference has largely determined surgical technique for idiopathic cases.³

While these techniques have been utilized for several decades, there is still a debate in the literature as to which technique yields better outcomes. A recent meta-analysis of the literature concluded that there is insufficient data to indicate which procedure is the preferred operative treatment.³ Moreover, some authors have reported that SD and AT have equivalent outcomes.^{4,5} However, there are other studies that suggest that SD is preferable because of a reduction in complications with equivalent recovery of ulnar nerve function.^{6,7} Additionally, the literature has conflicting reports of relative risk of reoperation, irrespective of procedure type. Many studies fail to look at this parameter and those that do have a wide range of reported values, varying anywhere from 0 to 19%.^{5,8} Because of the relative lack of data, the purpose of this study was to determine the rate of revision following cubital tunnel surgery and to compare revision rates between SD and AT in a large patient sample. Additionally, this study aimed to evaluate any patient variables that might be predictive of failure of cubital tunnel surgery, either SD or AT, resulting in revision surgery.

Materials and Methods

After Institutional Review Board approval was confirmed, a retrospective review was performed at a single institution. A query was done to identify all patients who underwent cubital tunnel surgery using Current Procedural Terminology code 64718 (neuroplasty and/or transposition; ulnar nerve at elbow) between January 2010 and December 2015. This billing record query identified 1,967 surgeries during the study period. These patients were operated on by 23 different surgeons at a single large orthopaedic institution. Exclusion criteria included a history of acute trauma, post-traumatic contracture release, or hardware removal (139 patients excluded), primary elbow procedure in addition to secondary cubital tunnel surgery (284), index procedure being a revision surgery (90), incomplete records (42), and age younger than 18 or older than 89 years (28). Following exclusions, there were a total of 1,384 cases that met criteria for inclusion in the study. Minimum follow-up for the study was 18 months with an average follow-up of 52 months for those individuals meeting inclusion criteria. Among the patients included in the study, there were 794 males (57.4%) and 590 females (42.6%). The average age of the study cohort was 53.8, with a standard deviation (SD) $\pm$ 14.5 years. As 131 patients had bilateral procedures (all at different surgical

sittings), the study ultimately included 1,253 patients undergoing the 1,384 CuTS surgeries. Patients with bilateral procedures were treated as a single entry for all variables that were independent of laterality and date of surgery. Patient variables that were dependent on laterality and date of procedure were treated as discrete entries. The choice of surgical technique, either SD or AT was determined by the operating surgeon in each case.

To evaluate any variables that might predispose to failure of initial cubital tunnel surgery, a nested case-control study was performed. The case group included all patients from the cohort that underwent revision. The control group for this study consisted of patients who underwent cubital tunnel surgery (either SD or AT) by the same surgeons within the same orthopaedic practice who did not require the need for subsequent revision surgery. Patients were selected from a group of 1,345 patients with CuTS undergoing surgery who did not require revision. Using a random number generator and selecting for a ratio of ~1:2 between cases and controls, 76 patients were selected as controls for this study. Demographic and disease-specific data were collected to compare with the case group consisting of 39 revision cases. Average follow-up for the cases was 53.1 and 54.0 months for the controls. The variables that were analyzed in the case-control study were age, gender, body mass index (BMI), length of symptom duration, electromyography nerve conduction velocity, hand dominance, concurrent surgery of ipsilateral upper extremity, smoking status, and diabetes status. In this study, Pearson's chi-square test was used for analysis of the categorical data and Student's *t*-test or the Mann-Whitney's *U*-test was used for continuous, independent variables. Power analysis for differences in revision rates indicated that 785 patients would be needed to achieve a power of 0.8 assuming a small Cohen effect size of 0.1. Variables that indicated a statistical association ($p < 0.1$) with risk for revision surgery on bivariate analysis were then included in a multiple logistic regression. As this study had a fixed number of 39 revision cases, our model was powered to analyze a maximum of three to four independent predictor variables. Odds ratios were determined for statistically significant predictors and the fit of the model was confirmed with Hosmer-Lemeshow's test.

Results

Among the surgeries that were included in the study, 979 were SD (70.7%), while the remaining 405 were AT (29.3%). In total, there were 39 primary cubital tunnel surgeries that resulted in a revision surgery (2.8%). Among the cases that resulted in a subsequent revision, SD was the index procedure in 30 patients and 9 were AT. The revision rate for SD was 3.1%, while the revision rate for AT was 2.2%. We did not identify a significant difference between revision rates for SD and AT ($p = 0.38$). The average age for the entire cohort of patients included in this study was 53.8 ± 14.5 . Comparing age between patients undergoing revision surgery and those who did not require revision surgery, those who required revision surgery were significantly younger (48.7 years) compared with patients who did not require revision surgery (53.9 years) with $p = 0.029$.

Results of the case-control study are presented in ►Table 1. Continuous variables that demonstrated a significant difference between cases and controls were nerve conduction velocity as well as duration of symptoms. Patients who required revision surgery demonstrated a higher average nerve conduction velocity (47.3 m/s) compared with patients who did not require revision surgery (43.2 m/s) with $p = 0.05$. Median duration of symptoms prior to initial cubital tunnel surgery was shorter in the patients who required revision (18 weeks) compared with patients who did not require revision surgery (43 weeks) with $p = 0.034$. BMI was similar between the two groups. For categorical variables, the only significant difference between the two groups was smoking status. Patients requiring revision were more likely to be current smokers (26.3%), compared with patients who did not require revision (11.8%) with $p = 0.050$. Gender, hand dominance, concurrent surgery on ipsilateral upper extremity, and diabetes status were similar between both groups.

Based on the bivariate analysis from the entire cohort, as well as the analysis of the case-control, the independent variables that were selected for analysis in the multiple logistic regression were age, nerve conduction velocity, duration of symptoms, and current smoking status. The final logistic model yielded significant associations of increased nerve conduction velocity and duration of symptoms with revision surgery and properly predicted 68% of total revision cases. An odds ratio of 1.05 ($p = 0.047$) was calculated for every 1 m/s increase in ulnar nerve conduction velocity above the mean and an odds ratio of 0.98 ($p = 0.045$) was calculated for each week of duration of symptoms above the mean. According to the multiple logistic regression, age and smoking status were not significant predictors of revision in the case-control study.

Discussion

A definitive surgical method for the treatment of CuTS remains elusive as meta-analyses on the topic have failed to show a significant difference in improvement outcomes

between the major treatment options, SD, and AT.³ Additionally, no single retrospective or prospective study has been able to demonstrate a significant difference in improvement outcomes between the two techniques either. Differences between the two procedures in the literature have focused on rates of complication. Kamat et al published a retrospective review of 480 patients over the course of 20 years showing that both SD and subcutaneous AT were effective at improving clinical outcome, but the AT group was more likely to experience localized elbow pain postsurgically.⁹ Similarly, Bartels et al published a randomized, prospective study that did not show any difference in outcomes between SD and subcutaneous AT, but did show that the transposition group had a statistically significant increase in the rate of complications, 31.1 versus 9.6%.⁶ However, another recent randomized, prospective study of 403 patients from Bacle et al showed no difference in either clinical outcome or in complication rate between SD and subcutaneous or submuscular AT.¹⁰

Many studies have all analyzed the differences in outcomes and complications between surgical techniques, but the literature has not provided the same level of analysis on rates of revision surgery. Several of the studies looking at outcomes do not report a revision rate. Other studies that report revision rates indicate that the studies were not designed to perform a comparison, lacking statistical power. Generally speaking, a total number of revisions in any given study were small due to the size of the patient samples and relatively low rates of revision. This resulted in variable revision rates being reported, ranging from 0 to 19% depending on the study.^{5,8} The Bacle et al's study, a study with one of the largest sample sizes, only reported six total revisions out of the 403 patients (1.5%), and thus were unable to make a statistical comparison.¹⁰ Zhang et al's study is one of the few studies that explicitly looked at comparative revision rates. They were not able to find a difference between the groups, overall, but among those who had previous elbow trauma, patients undergoing AT were more likely to need a revision surgery.¹¹ Certain

Table 1 Demographic and disease-specific data

Continuous variables Mean ± standard deviation	Revision cases (n = 39)	Controls (n = 76)	p-Value
Age	48.4 ± 14.3	53.3 ± 17.1	0.066
BMI	29.5 ± 6.5	28.8 ± 6.7	0.299
Follow-up (mo)	53.1 ± 19.1	54.0 ± 20.5	0.741
Symptom duration ^a (wk)	18	43	0.039
Nerve conduction velocity (m/s)	47.3 ± 8.1	43.2 ± 10.0	0.049
Categorical variables No. (%)			
Male gender	19 (48)	45 (57)	0.249
Dominant hand effected	17 (50)	28 (38)	0.256
Currently smoking	10 (26)	9 (12)	0.050
Diabetes	4 (38)	11 (14)	0.557
Concurrent surgery on ipsilateral upper extremity	19 (51)	46 (61)	0.314

Abbreviation: BMI, body mass index.

^aMedian values reported.

studies have looked at revision rates of SD without comparison. Kroegue et al, Goldfarb et al, and Gaspar et al found revision rates of SD of 19, 7, and 3.2%, respectively.^{8,12,13} Thus, based on this existing body of literature, revision rates comparing the two techniques for treating idiopathic CuTS have not been fully described.

The primary goal of this study was to describe the revision rate for the surgical treatment of idiopathic cubital tunnel. While this study did not find a statistically significant difference in revision rate between the two major surgical techniques, this study represents the largest patient sample size for a single study comparing outcomes between the two techniques to date. Additionally, the patients represented in this study were operated on by a large sample size of surgeons operating out of 28 different surgical centers within a single orthopaedic practice. Because of the size of the patient sample size and the variety of surgical locations pooled in our study, we believe our data may be generalizable to other patient populations. In this study, we excluded any patient with a history of acute traumatic elbow injury, posttraumatic contracture, or removal of hardware. Traumatic injuries that occurred in the distant past were only excluded if it was explicitly contributory based on notes from the operating surgeon. This was done because posttraumatic elbow stiffness is often an indication for AT and previous studies have suggested that clinical outcomes may be worse in patients who have posttraumatic as opposed to nontraumatic CuTS.^{14,15} Thus, including posttraumatic cases could create a selection bias whereby AT has worse outcomes. We also excluded any patient with a primary elbow procedure and a secondary cubital tunnel surgery. This was done because for certain elbow surgeries, anatomical considerations necessitate transposition, and thus, these cases did not fit our criteria for idiopathic CuTS.

Because of this large sample size, we were limited in that we were unable to analyze preoperative ulnar nerve function for the entire study population. For this reason, we performed a case-control analysis to determine any possible predictors of revision surgery following either in SD or AT. Comparison of the entire cohort of patients indicated that revision patients were on average younger, and the results from the case-control analysis and multiple logistic regression found that patients who required revision surgery on average had a faster nerve conduction speed across the elbow and had a shorter duration of symptoms prior to the time of surgery. The differences between the two groups are most likely explained by differences in approach to elderly patients and patients with more severe disease by surgeons, as well as differing goals and expectations of treatment among these patients. Some studies about CuTS have found that old age and severe disease are adverse prognostic factors in the recovery from CuTS.^{16,17} While these reports may seem to contradict the data in this study, it stands to reason that elderly patients with severe disease, especially in the setting of previous surgery, may not be treated as aggressively as a younger patient with similar manifestations of CuTS. Consideration for revision surgery may also be delayed among older patients because it has been shown

that overall recovery is not as complete and takes longer than with younger patients.¹⁸ Additionally, as was concluded in Kroegue et al, patients with severe disease who have been having symptoms for a longer period are more likely to be satisfied with any degree of improvement from surgery despite a higher likelihood of residual symptoms. Additionally, within this same cohort, patients with mild disease, per McGowan grading scale, were more likely to gain complete resolution of symptoms, but any residual deficits were poorly tolerated and thus also more likely to undergo revision.⁸ Our data agree with this finding and suggest that an important predictor of revision in cubital tunnel surgery is mild disease. This can most likely be attributed to differences in both provider and patient preferences when dealing with indications for revision surgery in mild versus advanced CuTS.

One limitation of our study is that we were unable to assess postoperative symptom severity due to the lack of availability and standardization of documentation. This is a variable that we would have been useful for our analysis. Additionally, having reported McGowan scores would have been helpful to be able to standardize severity of symptoms, but again, these data were not available to us. Additionally, we did not have access to standardized preoperative severity data. Without preoperative severity data, we were unable to determine whether or not the SD group and the AT were similar in their degree of ulnar neuropathy prior to surgery. As mentioned earlier, we limited our analysis to cases of idiopathic CuTS in an attempt to control for preoperative conditions that could result in worse postoperative outcomes. However, without quantitative and standardized measures of preoperative severity, we cannot know for certain that a selection bias does not exist between the SD and AT groups that could influence the rates or revision surgery. Moreover, the reporting issue that plagues the issue of revision ulnar nerve surgery in general is the dependence on subjective symptoms rather than objective symptoms when indicating a patient to revision surgery. This is evident to us both on our observation in practice, documentation found in the medical records, and in prior series reporting on ulnar nerve revision surgery. As mentioned earlier, the patients in this study were operated by several different surgeons. While this may provide external validity, there is concern that this could result in a variable management strategies and treatment techniques, providing another source of possible bias.

In conclusion, overall revision rates following surgery for idiopathic CuTS were low in this study. Furthermore, we did not observe a significant difference in revision surgery rates between SD and AT for the treatment of idiopathic CuTS in our study cohort. However, age, increased nerve conduction velocity, as well as shorter duration of symptoms was shown to be associated with an increased risk for revision surgery. This is thought to be due to differences in goals and expectations of treatment that can vary with age, severity of disease, as well as duration of current symptoms.

Conflict of Interest

None declared.

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