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Comparative Morbidity of Cubital Tunnel Surgeries: A Prospective Cohort Study

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Abstract

Purpose—Randomized controlled trials have not identified a superior surgical approach to cubital tunnel syndrome surgery. This study evaluates the early morbidity of open *in situ* decompression and transposition.

Methods—This prospective cohort study enrolled 125 adult patients indicated for cubital tunnel surgery at a tertiary institution. Exclusion criteria included preoperative use of narcotics and concurrent elbow procedures. *In situ* decompressions (n=47) and ulnar nerve transpositions (n=78) were performed. Data were collected by independent clinicians at 3 postoperative intervals: 1–3 weeks, 4–8 weeks, and >8 weeks. Postoperative data quantified surgical morbidity: Visual Analog Scale (0–10) surgical site pain, narcotic consumption, patient-reported disability (Levine-Katz, Patient Reported Elbow Evaluation [PREE] scores). Olecranon paresthesia and wound complications (hematoma, drainage, infection) were recorded.

Results—No preoperative differences in age, sex, or the presence of pain existed between the surgical groups. Surgical site pain was not significantly different at any time. Following transposition, a significantly greater percentage of patients were using narcotics at 4–8 weeks after surgery and the average total morphine equivalents consumed per patient was significantly greater. Both Levine-Katz and PREE scores indicated greater disability at 1–3 and 4–8 weeks after transposition, but this significant difference resolved by final follow-up. Olecranon paresthesias occurred after both procedures but were significantly less frequent at 4–8 weeks and >8 weeks after decompression. Twelve hematomas occurred following transposition (15%) with 1 requiring operative debridement and 5 hematomas resolved with non-operative treatment after *in situ* decompression (11%).

Conclusions—Ulnar nerve transposition imparts greater surgical morbidity than decompression with greater narcotic consumption, more patient-reported disability up to 8 weeks postoperatively and more persistent olecranon paresthesia. However, most differences in surgical morbidity are transient with resolution after 8 weeks following surgery.

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Level of Evidence—II Therapeutic

Keywords

Cubital Tunnel; In Situ Decompression; Morbidity; Transposition

INTRODUCTION

In recent decades, the rate of surgical management for cubital tunnel syndrome has increased in the United States and in Europe.^{1, 2} Despite the increased incidence of surgical management, there is neither a consensus on the best surgical procedure nor a standardized treatment algorithm for idiopathic cubital tunnel syndrome.^{3–9}

While multiple studies have compared outcomes of in situ decompression to anterior transposition and/or medial epicondylectomy,^{3, 5–7, 10, 11} no procedure has proven superior. A meta-analysis of randomized control trials confirmed no difference in clinical and functional outcome between the various treatment methods.¹² Previous studies have also failed to inform surgical decision making^{4, 13–15} according to disease severity. Thus, surgeons are left to determine their operation of choice for cubital tunnel syndrome on a case-by-case basis.¹⁶

Assuming a similar ultimate neurologic outcome, differences in the early morbidity between procedures becomes more relevant when recommending surgery. The primary aim of this study was to compare the morbidity of common cubital tunnel surgeries (*in situ* decompression and anterior transposition). We tested the null hypothesis that each surgery would impart similar early surgical morbidity (surgical site pain, narcotic usage, functional impairment, complications).

METHODS

Study Design

Institutional review board approval was obtained prior to initiating this prospective cohort study. One hundred twenty-five individuals (18 years of age) were consented and enrolled in the study. Patients were informed that the study was designed to assess outcomes after their type of cubital tunnel surgery but enrollment did not involve descriptions of the alternative procedure. Patients were diagnosed with cubital tunnel syndrome based on a combination of symptoms, signs and electrodiagnostic testing including: paresthesias in ring and small finger, atrophy or weakness of ulnar nerve-innervated hand intrinsic musculature, positive nerve percussion or flexion-compression testing over the ulnar nerve at the elbow, and decreased nerve conduction velocity across the elbow. For each patient, the diagnosis was established based on the overall clinical impression of a hand-fellowship trained, attending surgeon. Patients underwent operative intervention at a single tertiary care center after failing non-operative management (night time pillow splinting and activity modification). Forty-seven patients underwent *in situ* decompression and 78 patients underwent ulnar nerve transposition (35 subcutaneous, 43 submuscular). Inclusion required English proficiency and anticipated follow-up at our institution. Exclusion criteria included

the following: preoperative use of narcotics determined by patient self-report, a history of cervical myelopathy or radiculopathy affecting the operative extremity, revision cubital tunnel surgery, and concurrent elbow surgery. The choice to perform an open *in situ* decompression or ulnar nerve transposition was left to the discretion of the attending physician's clinical judgement and did not affect enrollment in the study. Five of 6 surgeons offer both procedures while one surgeon only offers transposition and contributed 11 transpositions to this study. In our practice, both *in situ* decompressions and transpositions are performed with longitudinal incisions that are placed over the course of the ulnar nerve centered on the posterior-medial elbow. While exact incision lengths are not standardized, *in situ* decompressions are consistently performed through smaller skin incisions than transpositions. Querying surgeons regarding incision length indicated that decompressions routinely require 2–4cm incisions, while transpositions are completed with 8–10cm incisions. Postoperatively, *in situ* decompressions were placed in long arm soft dressings while transpositions were immobilized in long arm plaster splints until the first postoperative visit at 8–10 days after which both groups were allowed full elbow motion.

Data Collection

Patients completed patient-reported questionnaires pre-operatively and then at 1–3 weeks, 4–8 weeks and >8 weeks (mean 12 weeks, range 9–26) postoperatively. Visual analogue scales quantified preoperative pain related to the cubital tunnel syndrome and also assessed general pain perception from common experiences (pain from stubbing toe, pain from a paper cut)¹⁷ The general pain questions were collected to examine for potential differences in pain tolerance between the groups as such standardization for sensory experiences has been suggested in other fields using VAS scoring.¹⁸ Postoperative visual analogue pain scales quantified surgical pain (incisional pain at rest, while moving, while placing the arm on a surface). We quantified the number of pain pills consumed since surgery by counting pills remaining in bottles at the subsequent three postoperative visit intervals (1–3, 4–8, and >8 weeks). As a variety of narcotic prescriptions were provided, narcotic consumption was converted to morphine equivalents consumed prior to statistical analysis.

Disease-specific (nerve compression: Levine-Katz total score) and region-specific (elbow: Patient Rated Elbow Evaluation [PREE]) patient-reported outcomes were collected in self-administered written form. The Levine-Katz questionnaire scores patients based on symptoms and function.^{19, 20} The survey was originally validated for carpal tunnel syndrome¹⁹ but it has been used in previous studies evaluating cubital tunnel syndrome treatment outcomes.^{21, 22} The PREE was included to determine if the findings would demonstrate consistency. The PREE produces scores on a scale of 0 (no disability) to 100 (severe disability) with regards to both pain and function with elbow-associated activities.²³ This questionnaire has also been previously used to evaluate cubital tunnel syndrome.^{21, 22, 24}

Surgical complications were recorded. At each visit, we examined for subjective paresthesias over the olecranon. These paresthesias were assessed by differences detected on light touch directly over the olecranon process and proximal subcutaneous border of the ulna between the affected and unaffected elbow. Examination also determined if there was a

hematoma (present/absent), infection, or wound dehiscence. A final record review at greater than 1 year after surgery was conducted to determine if surgical revision had occurred.

Statistical Analysis

An *a priori* sample size estimate was performed. We considered primary outcomes of the Levine-Katz Questionnaire and VAS pain scores to be analyzed with student's t-tests. Based on other publications, a minimal clinically important difference (MCID) of 1.4cm was assumed for the VAS pain scores and a value of 0.74 for the total score of the Levine Katz questionnaire.^{19, 25, 26} Analysis of the Levine-Katz scores required more patients and the sample size analysis determined that 66 patients (22 in one group, 44 in other group) would be required to detect this minimally clinical important difference with a beta of 0.8 and an alpha of 0.05.¹⁹ Study enrollment continued until the number of patients at each time point was sufficient for analysis. The percentage of patients following up and contributing study data were similar at each time point after decompression and transposition respectively (1–3 week n= 45 [96%], 67 [86%]; 4–8 week n= 31 [66%], 53 [68%]; >8weeks n= 28 [60%], 47 [60%]).

All statistical comparisons tested for differences between the surgical groups of patients undergoing either *in situ* decompression or anterior transposition of the ulnar nerve. Bivariate analysis with independent t tests (Mann-Whitney U test for non-normally distributed data) and chi square testing were conducted on continuous and categorical variables as necessary. Postoperative incisional pain comparisons tested pain based on each group's average surgical site pain reported combining pain at rest, with motion, and with pressure against a surface. As no significant difference was demonstrated between the groups on VAS for pain experiences (stubbing toe/paper cut), postoperative surgical pain levels were analyzed without any corrective factor based on those general pain experience scores. Available data were analyzed without imputing missing data.

RESULTS

No preoperative differences in age, sex, or the presence of reported pre-operative pain existed between the *in situ* and transposition groups (Table 1). The groups reported comparable preoperative pain levels, Levine Katz total scores, and PREE scores. Mean number of days from surgery to each of the 3 postoperative assessments were similar for patients after decompression (12 days, 42 days, 86 days) and transposition (13 days, 41 days, 86 days).

VAS scores for average surgical site tenderness were not statistically different and failed to demonstrate a difference exceeding our estimated minimal clinically important difference between the groups at each postoperative interval (Table 2). The percentage of patients using narcotic pain medication was similar between groups at 1–3 weeks after surgery but significantly more patients were still using narcotics 4–8 weeks after transposition (Table 3). *In situ* decompression resulted in significantly fewer total morphine equivalents consumed per patient who used narcotics (43 vs 225, $p<0.05$) during their postoperative course. This difference in morphine equivalents equates to approximately 36 more 5mg hydrocodone tablets consumed per patient (Table 3).

Both procedures resulted in clinically relevant improvement in Levine-Katz scores from preoperative to final follow-up. However, *in situ* decompression resulted in significantly better Levine Katz scores at 1–3 weeks and 4–8 weeks compared to patients following anterior transposition. PREE scores substantiated this pattern with patients undergoing *in situ* decompression being associated with significantly better scores at 1–3 weeks and 4–8 weeks postoperatively. Neither patient-reported questionnaire indicated a significant difference at final follow-up (Table 4).

Olecranon paresthesias were frequent in each surgical group. This paresthesia was significantly less prevalent after *in situ* decompression at 4–8 weeks and >8 weeks after surgery. At final follow up, 11% of patients treated with *in situ* decompression and 32% of patients treated with transposition still experienced olecranon paresthesias (Table 5). Twelve postoperative hematomas occurred following transposition (15%) with 1 requiring operative debridement. Five hematomas occurred in the decompression group (11%) and all were managed non-operatively. No other wound complications occurred. Final record review at a minimum of 1 year (mean 2.7 years), identified 6 revision surgeries for cubital tunnel symptoms after decompression (13% of decompressions) and 2 revisions after transposition (3% of transpositions).

DISCUSSION

Our data indicate a transient, but significant and clinically relevant, decreased morbidity of *in situ* decompression compared to ulnar nerve transposition with better patient reported outcomes (Levine Katz, PREE), reduced narcotic use, and more rapid resolution of olecranon paresthesia within the first 2 postoperative months. Beyond 8 weeks after surgery, only an increased prevalence of olecranon paresthesia distinguished transposition from decompression.

Previous studies have examined the incidence of complications after surgery for cubital tunnel syndrome. Biggs and Curtis⁵ compared *in situ* decompression and anterior transposition finding that 14% of their anterior transpositions developed deep infections (two of which required operative intervention) while no deep infections were observed after decompression. They attributed this increased incidence of infection to the local ischemia and dead space created during surgical dissection as well as the longer operative time associated with transposition surgery. Bartel et al. found a significant increased incidence of lost sensation (18.6% to 2.5%) and infection (9.3% to 2.5%) in individuals treated with anterior transposition compared to simple decompression, respectively.³ Using Bartel and Biggs data as well as four other randomized control trials, Caliandro et al.'s Cochrane Review concluded that anterior transposition has an increased risk of infection and pain postoperatively.¹² Although we did not demonstrate a significant difference in the incidence of infection or hematoma between our surgical groups, the one hematoma requiring operative drainage occurred after transposition surgery. Coupling this with more persistent olecranon paresthesiae after transposition, we believe that our data are consistent with these previous studies suggesting a greater incidence of complications associated with transposition surgery. Our data compliment this data by adding elements of patient-reported

outcome measures and assessment of surgical site pain as well as narcotic use to further clarify the differential surgical morbidity.

Narcotic consumption after surgery is coming under greater scrutiny as the risks of addiction and complications from both use and misuse by patients and by those around them are becoming more evident.^{27–31} Although it is not traditionally considered a surgical complication, prolonged narcotic use in opioid-naïve patients undergoing ulnar nerve surgery is of real concern.^{32, 33} Eight percent of our patients continued to use narcotics at an average of 3 months after transposition. This is only slightly less than the 13.8% of 4,027 patients, identified by Johnson et al., who continued to fill opioid prescriptions at 3 months after cubital tunnel surgery using administrative data.³⁴ Notably, the study by Johnson et al. described their data for “ulnar nerve release” but the CPT code used does not distinguish between decompression and transposition. Going forward, we expect that the risk of prolonged narcotic use postoperatively will be weighted even greater and that alternative pain management protocols will be emphasized. We acknowledge that keeping pain logs and having pill counts performed could influence patient behavior or reduce narcotic use. This could result in our data underestimating usual narcotic consumption but as these methods applied to both groups we do not expect either group to have been differentially affected.

Assuming equivalent ultimate neurologic recovery, reduced surgical morbidity would favor the choice of *in situ* decompression over transposition. However, we acknowledge a debatable increased risk of revision surgery after decompression; a risk which appeared present in our series. Goldfarb et al. identified a 7% incidence of revision after decompression and Krogue et al.³⁵ found that 19% (44/231) of *in situ* decompressions had to be revised for either persistent or recurrent symptoms.³⁶ That incidence of revision exceeded others’ experience including Song et al.³⁷ who reported only 1 revision transposition after 39 primary decompressions, although nearly half the patients showed either no change in 2-point discrimination or slight worsening at 1 year. Thus, some of the discrepancy between estimated risks of revision after decompression may be attributable to surgeon tendency toward revision surgery when facing persistent symptoms after decompression. Considering the outcomes after revision surgery, both Aleem et al.²¹ and Gabel et al.³⁸ documented outcomes inferior to primary surgery suggesting that secondary transposition does not replicate the outcomes of primary transposition. Based on these data, the surgeons in our group do discuss this increased chance of revision when offering *in situ* decompression.

Several limitations are inherent to our study. The observational nature of the study may suffer from bias. Each surgeon in the group determined the type of treatment based on preference. We did not identify any relevant preoperative differences between the groups but this non-randomized design risks bias due to unmeasured confounders. Second, we have not considered all surgical interventions for cubital tunnel as our surgeons infrequently perform medial epicondylectomy and do not perform endoscopic decompression. Further, we did not distinguish between the final depth of the anterior transposition (e.g., subcutaneous, submuscular) based on similar skin incisions and nerve dissection. It could be argued that muscular release required for submuscular transposition may represent a bias toward greater morbidity. However, a *post-hoc* comparison of subcutaneous and submuscular transpositions

confirmed that differences in our primary outcomes never exceeded clinically relevant thresholds for postoperative VAS pain (range 0.2–0.7) or total Levine Katz score (range 0.1–0.6). Patients lost to follow-up also risk introducing bias in our study although patients in each surgical group were similarly likely to complete follow-up such that neither group was disproportionately affected. Finally, the study was not designed to compare neurologic outcomes as final nerve function may evolve over a much longer period but we have documented the incidence of revision surgery for cubital tunnel symptoms. Our final follow-up was chosen to have captured all wound related complications and include the period reasonably expected to show differences in pain and function attributable to the extent of surgical dissection.

The popularity of *in situ* decompression has increased in recent years as randomized controlled trials have not demonstrated the superiority of any single surgical procedure for cubital tunnel syndrome.³⁹ We believe our data indicating reduced surgical morbidity associated with open *in situ* decompression versus transposition offers another factor to consider when choosing a primary surgery for cubital tunnel syndrome. Although patient-reported health measures indicate similar outcomes after 8 weeks, earlier improvement or more rapid return to function may be highly valued by some patients. Ultimately the choice between surgical procedures is affected by surgeon experience and patient preferences, and our group continues to perform both *in situ* decompressions and anterior transpositions.

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Table 1

Preoperative data according to surgical group.

	In situ Decompression (n=47)	Transposition (n=78)
Age (SD)	51 (12)	49 (13)
Male	49%	54%
Preoperative Pain Present	38%	39%
Average Preoperative Pain (SD)	4.1 (3.2)	4.5 (3.0)
Average Pain Stubbing Toe/Paper Cut (SD)	4.2 (2.0)	4.2 (2.0)
Levine Katz Score	2.5 (0.8)	2.5 (0.9)
PREE Score	44 (25)	54 (25)

Table 2

VAS pain scores for surgical site according to surgical group.

	In situ Decompression	Transposition	P
1–3 weeks	2.5 (2.0)	3.5 (2.3)	0.06
4–8 weeks	1.9 (2.1)	2.7 (2.1)	0.52
>8 weeks	1.2 (1.5)	2.1 (2.1)	0.05

Table 3

Percentage of patients using narcotics and average consumption according to surgical group.

	In situ Decompression	Transposition	P
1–3 weeks (SD)	47%	59%	0.19
4–8 weeks (SD)	11%	26%	<0.05
>8 weeks (SD)	2%	8%	0.19
Median total morphine equivalent consumption per patient (IQR) *	43 (143)	225 (384)	<0.05

* Interquartile Range

Table 4

Postoperative patient-reported outcome measures use according to surgical group.

	In situ Decompression	Transposition	P
Levine Katz Score			
Pre-operative	5.6 (1.4)	5.7 (1.7)	0.87
Postoperative			
1–3 weeks (SD)	4.5 (1.7)	5.5 (1.9)	<0.05
4–8 weeks (SD)	3.5 (1.2)	4.8 (2.2)	<0.05
>8 weeks (SD)	3.3 (1.3)	3.4 (1.5)	0.75
PREE Score			
Pre-operative	44 (25)	54 (25)	0.08
Postoperative			
1–3 weeks (SD)	30 (26)	49 (29)	<0.05
4–8 weeks (SD)	18 (18)	39 (30)	<0.05
>8 weeks (SD)	13 (16)	19 (22)	0.32

Table 5

Percentage of patients with olecranon paresthesia according to surgical group.

	In situ Decompression	Transposition	P
1–3 weeks	36%	46%	0.26
4–8 weeks	16%	43%	<0.05
>8 weeks	11%	32%	<0.05