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Retrospective, nonrandomized analysis of subcutaneous anterior transposition versus in situ decompression of the ulnar nerve of military service members

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Hypothesis: The objective of this study was to compare the subjective and objective midterm functional clinical outcomes of subcutaneous anterior transposition (SAT) vs. in situ decompression (SD) of the ulnar nerve for the treatment of cubital tunnel syndrome.

Methods: The US Military Health System was queried to identify all cases of ulnar neuroplasty (Current Procedural Terminology code 64718) between 2006 and 2010. Patient charts were reviewed to identify cases of isolated SAT and SD, and demographic and surgical variables were collected. The primary outcome variable was the Disabilities of the Arm, Shoulder and Hand score. The inclusion criteria were isolated primary SAT or SD and adult active-duty service members with a minimum 6-year telephone follow-up. Terminal follow-up was determined by a telephone interview. The exclusion criteria were revision procedures, trauma, cases that included other procedures (eg, medial epicondylectomy, submuscular transposition, arthroscopy, or fracture fixation), non–active-duty service members, patients without a minimum 6-year telephone follow-up, and patients who had incomplete medical records or could not be reached to complete the survey.

Results: A total of 65 SD and 67 SAT patients met the inclusion and exclusion criteria, with a 72% telephone interview response rate. The average age was 32.3 years for all patients, with an average follow-up period of 6.5 years for SD patients and 6.3 years for SAT patients. SD patients had a lower mean Disabilities of the Arm, Shoulder and Hand score than SAT patients. No difference in reoperation rate was found.

Conclusion: The active-duty cohort reported positive outcomes and a low reoperation rate at 6-year follow-up both after SAT and after SD. SD patients had mildly superior clinical outcomes compared with SAT patients.

Institutional review board approval was obtained at the outset of our retrospective study (William Beaumont Army Medical Center Institutional Review Board approval No. 15-22).

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Cubital tunnel syndrome (CuTS) is the second most common compressive neuropathy.[5] Symptoms initially may be limited to transient numbness of the fourth and fifth digits; in advanced disease, however, muscle atrophy, permanent loss of sensation, and joint contracture may develop.[25] Nonoperative treatment is often successful in mild cases, which may include using an extension splint while sleeping, avoiding resting the elbow on a hard surface in flexion, and refraining from triceps strengthening.[9,35] When nonoperative measures fail, initial surgical treatment frequently consists of in situ decompression (SD)[5-9] or subcutaneous anterior transposition (SAT)[13,27,32,36,38] and submuscular transposition.[1]

Both SD and SAT have associated risks and benefits. Although SD may limit excessive scarring and devascularization of the nerve,[31] the procedure may lead to an incomplete release of compressive structures, does not reduce the tension on the nerve, and may precipitate subsequent nerve instability[10,13] and persistent symptoms.[26,38] Consequently, a revision rate after SD between 0.9% and 19% has been reported.[13,20,38] Finally, some authors have argued that SD may not be indicated for the subluxating nerve.[4,5,30] SAT decreases the tension on the ulnar nerve in flexion,[11,29] which theoretically preserves nerve vascularity and function.[22] In addition, the SAT technique may create a potential iatrogenic site of compression at the fascial sling.

Several large prospective studies[3,4,14,30] and meta-analyses[8,23,33,38] have shown no difference (in outcomes) between the techniques for CuTS, even in patients with preoperative ulnar nerve subluxation.[3,16] However, the outcomes of these 2 procedures have never been compared in a highly active population with increased upper-extremity physical demands. We conducted a retrospective comparison of active-duty service members with CuTS who had undergone either SD or SAT, and we hypothesized that there would be no difference between the 2 cohorts with respect to outcome scores, return to full military duty, and complications.

Methods

The Military Health System Management Analysis and Reporting Tool (M2) was reviewed for all US military service members who underwent cubital tunnel surgery (Current Procedural Terminology code 64718) from 2006 to 2010. The M2 database is a means to systematically query the military-wide medical record system (Armed Forces Health Longitudinal Technology Application [AHLTA]) by Current Procedural Terminology code. After patients were identified using the M2 database, further information was acquired within AHLTA for study purposes. The primary outcomes of interest were the Disabilities of the Arm, Shoulder and Hand (DASH) score and complication rate. The inclusion criteria consisted of active-duty service members who underwent either subcutaneous transposition (SAT) of the ulnar nerve or decompression (SD) of the ulnar nerve, had a minimum 6-year telephone follow-up, and were available for the final telephone interview.[34] Latest follow-up was determined as the time from the index surgical procedure to the date of the telephone interview. The exclusion criteria were as follows: patients who were retired at the time of surgery, patients who were family members of service members, patients who underwent other procedures in conjunction with the cubital tunnel treatment including fracture fixation or carpal tunnel release, bilateral cases, patients who underwent blast injuries in combat, patients with a minimum telephone follow-up of less than 6 years, and patients who could not be reached to complete a telephone survey. Finally, patients who underwent operative treatment of CuTS other than SAT or SD including submuscular transposition or medical epicondylectomy were also excluded. They were excluded because these procedures are used most often in the revision setting at our institution,[3] which was not the aim of this analysis.

The military electronic medical record system AHLTA was queried, and patients treated at a multitude of Department of Defense hospitals by a multitude of surgeons were included. Demographic information including age, sex, military rank, branch of service, diagnosis, surgical procedure, tobacco use, and date of surgery was recorded. The diagnosis was determined by the treating surgeon. A major complication was defined as any complication that required another operation. A minor complication was defined as any complication that did not require revision surgery; this included any worsening of subjective preoperative paresthesia, pain, or weakness. Functional and occupational outcomes including pain (pain on an average day, as determined by the patient, rated from 1-10, with 10 being the worst pain imaginable) and DASH scores were recorded via telephone interviews that were all performed by the same primary investigator.[21] For the DASH questionnaire, a score between 0 and 100 is generated, with 0 corresponding to no disability and 100 corresponding to completely disabled.[17,18] Table I shows the number of push-ups a patient could perform, which was based on the patient's best estimate. Push-ups are required for the military physical fitness test, and the number can be used to infer a return to athletic activity. The ability to remain in the military for 2 years was an outcome measure included in this study because it is indicative that the patient is able to perform activities with generally heavier-duty physical demands and pass the military physical fitness test. The telephone interview used a standard formatted script and served as the last data point for follow-up calculation.[21] Nerve subluxation was not included in the analysis as this was not uniformly reported in the medical record.

To determine statistical power, an effect size of 20% was assumed, as this was the difference in complication rates reported

Table I Functional outcomes and complications comparing in situ release with subcutaneous transposition of ulnar nerve

Outcome variable	Simple decompression (n = 65)		SAT (n = 67)		*P* value
	Mean ± SD or %	95% CI	Mean ± SD or %	95% CI	
DASH score	11.4 ± 12.8	8.2-14.6	21.5 ± 17.9	17.2-25.9	<.05* (*t* test)
No. of push-ups	35.0 ± 25.9	28.6-41.4	33.8 ± 25.4	27.6-40.0	.78 (*t* test)
Still in military 2 yr after surgery	77	65-86	84	73-92	.39 (Fisher test)
Minor complication	45	32-57	70	58-81	<.05* (Fisher test)
Pain at rest	31	20-43	45	33-57	.11 (Fisher test)
Pain with activity	43	31-56	57	44-69	.16 (Fisher test)
Paresthesia	40	28-52	61	53-70	<.05* (Fisher test)
Weakness	40	28-52	64	53-76	<.05* (Fisher test)
Major complication	5	1-10	10	4-21	.31 (Fisher test)

SAT, subcutaneous anterior transposition; *SD*, standard deviation; *CI*, confidence interval; *DASH*, Disabilities of the Arm, Shoulder and Hand.
* Significant at $\alpha = .05$. The *t* test was used for comparison of parametric means, and the Fisher exact test was used for categorical data.

between SD (10%) and SAT (30%).[3] To test the null hypothesis that the complication rates for the 2 procedures are the same, using the χ^2 two-tailed test with $\alpha = .05$ and 80% power, we needed 63 participants per procedure, for a total of 126. For comparison of the mean DASH score and mean number of push-ups, the 2-tailed *t* test was used. The Fisher test was used to compare percentages for a number of binary outcome variables (Table II). The major complication rates were not compared because the incidence was too infrequent.

Results

We initially identified 249 patients, of whom 183 underwent SD or SAT and met the inclusion and exclusion criteria. We initially excluded 66 patients: 26 had blast injuries, 33 underwent submuscular transposition, 2 underwent arthroscopy, 2 underwent bilateral CuTS procedures, and 3 underwent other concomitant procedures. An additional 51 patients who were unable to be contacted for telephone interviews were excluded in the final analysis (72.1% response rate). The final analysis included 132 patients: 65 SD and 67 SAT patients. The average age was 32.3 years for all patients, with an average follow-up period of 6.5 years for SD patients and 6.3 years for SAT patients (Table III). At final follow-up, no patients underwent revision procedures including SD to SAT or revision from either primary procedure to submuscular anterior ulnar nerve transposition.

SD patients had superior DASH scores to SAT patients (11.4 vs. 21.5, $P < .05$). In addition, SD patients had fewer minor complications than SAT patients (45% vs. 70%, $P < .05$) (Table I). The SAT (10%) and SD (5%) cohorts both experienced major complications.

Discussion

In this analysis, we compared the outcomes and complications of CuTS in the active-duty population treated with SD or SAT. There were 2 key findings: First, SD patients had superior DASH scores. Second, SD patients had a statistically significantly lower minor complication rate than SAT patients (45% vs. 70%) and no difference in major complications. We conclude that there is no advantage to SAT over SD in primary surgically treated CuTS even in a high-demand, physically active population.

In our cohort, SD patients had a lower average DASH score (11.4) at terminal telephone follow-up than SAT patients (21.5). The difference was clinically significant, as it surpassed the threshold for the minimal clinically important difference in the DASH score (8-11).[12,28] Large prospective investigations[3,4,14,30] and meta-analyses[2,6,23,39] have generally shown no difference between SAT and SD in terms of the Short Form 36 score,[14] persistent pain and paresthesia,[3,19,24] Bishop score,[14] McGowan grade,[19,24] patient satisfaction,[4,19] and clinical improvement.[4,24,30,37] The abundance of evidence from the civilian literature supports SD as being at least equivalent to SAT.

There are 2 possible reasons for the discrepancy in the minimal clinically important difference in DASH scores and considerably higher rates of minor complications between SAT and SD: First, it is possible that the DASH score is not sufficiently sensitive to account for minor postoperative complications. In addition, although the verbal DASH survey closely replicates the written DASH survey,[21] the effect of directly asking a patient about complications is not known. Second, the activity demands of service members (push-ups), as well as an emphasis on physical readiness and a timely return to duty, precipitate some of the minor postoperative complications, such as continued pain.

In parallel to our military analysis, most studies comparing SAT and SD have shown no difference in complication rates.[14,19,30] However, 2 studies reported a higher rate of wound infection with SAT.[4,6] In addition, a Dutch study including 150 patients randomized to SD or SAT experienced similar findings of equivalent outcomes with a higher complication rate in the SAT arm.[3] In fact,

Table II Mean multiple linear regression and logistic regression analyses evaluating influence of demographic factors on outcomes after cubital tunnel surgery

Functional outcome	Risk factor	Data	*P* value
DASH score	Age, regression coefficient ± SE	−0.09 ± 0.20	.63
	Sex, mean ± SD		.21
	Male	15.7 ± 16.1	
	Female	19.8 ± 17.4	
	Tobacco use, mean ± SD		.46
	Yes	17.9 ± 17.6	
	No	16.0 ± 15.9	
No. of push-ups	Age, regression coefficient ± SE	−0.34 ± 0.29	.24
	Sex, mean ± SD		<.05
	Male	37.7 ± 25.4	
	Female	21.5 ± 22.1	
	Tobacco use, mean ± SD		<.05
	Yes	28.1 ± 27.1	
	No	36.9 ± 24.6	
Still in military 2 yr after surgery	Age, OR (95% CI)	0.97 (0.92-1.03)	.30
	Sex, male vs. female, OR (95% CI)	1.19 (0.39-3.61)	.76
	Tobacco use, OR (95% CI)	0.56 (0.19-1.67)	.29

SE, standard error; *SD*, standard deviation; *OR*, odds ratio; *CI*, confidence interval; *DASH*, Disabilities of the Arm, Shoulder and Hand.

Table III Demographic variables of 132 service members with cubital tunnel syndrome

Demographic factors and outcomes	Data
Age at surgery, mean ± SD, yr	32.3 ± 7.4 (N = 132)
Age categories, n (%)	
<20 yr	2 (2)
20-29 yr	57 (43)
30-39 yr	54 (41)
40-49 yr	16 (12)
≥50 yr	3 (2)
Male, n (%)	105 (80)
Group, n (%)	
In situ release of ulnar nerve	65 (49)
Subcutaneous transposition	67 (51)
Hand dominance, n (%)	
Right	111 (85)
Left	20 (15)
Surgical side, n (%)	
Right	61 (46)
Left	71 (54)

SD, standard deviation.

the complication rate of SAT in the Dutch study was 3 times higher than that of SD (31% vs. 9%). The complications included sensibility loss around scar, superficial infection, deep infection, elbow pain, seroma, and wound dehiscence. The authors suggested that as SAT requires more significant dissection and tissue displacement, there is a higher likelihood of injury to the medial antebrachial cutaneous nerve. A final possible contributing factor is that SD compromises the vascularity of the nerve to a lesser extent than SAT.[15,30]

Although our high incidence of minor complications parallels another study of patients younger than 30 years,[16] our complication rate is higher than that of many other similar studies.[3,4,33] There are 3 possible explanations: First, active-duty service members are subject to a higher degree of daily physical demands, which may predispose them to incomplete recovery and complication rates. Second, follow-up averaged 6.5 years, which increases the length of time for potential complications to arise. Third, our analysis methods likely skewed our complication rate. Whereas the patients in the analysis of Bartels et al[3] filled out a questionnaire,[1] other studies evaluated complications using a telephone interview with open-ended questions[30] or a physician's findings from a clinical encounter.[19] In our analysis, a telephone survey was conducted in which patients were asked whether they had specific complications; however, this method has an unknown effect on the complication rate.

A review of almost 26,000 cases of cubital tunnel release identified a revision rate of 1.4%.[7] Factors associated with revision surgery were age younger than 65 years and both modifiable and nonmodifiable medical comorbidities. Notably, preoperative subluxation of the ulnar nerve was not a risk factor for revision. These results were paralleled by a second review that also focused on risk factors for revision surgery after cubital tunnel release.[13] In this second analysis, the revision rate was 3.2%, and the only risk factor identified for revision surgery was age younger than 50 years. In addition, in part because of the higher complication rate associated with SAT, the cost associated with SAT is 2.4 times higher than that of SD.[2] The findings of these 2 studies suggest that a preoperative subluxating ulnar nerve does not preclude SD as a safe and cost-effective treatment method.

There are a number of limitations in this analysis. First, the military-wide retrospective nature of this study limits the ability to identify and control for specific surgical techniques. The retrospective nature of this study makes controlling the diagnosis and intervention impossible. Furthermore, certain preoperative diagnostics, particularly electromyography and nerve conduction studies, are lacking. In addition, it is possible that this study does not report certain complications. If a specific complication was not recorded in the notes or recalled by the patient, the complication would not be reported in this study. Second, the telephone survey introduced both recall bias from the patient and observer and reporting bias by the research team. Third, because preoperative ulnar nerve subluxation was not uniformly recorded in the medical records, these data were not included in the study. Fourth, our response rate was 72.1%. It is possible that patients who had better records or who remained on active duty had better surgical results and thus skewed our population that responded to our telephone calls, representing sampling bias. Fifth, the diagnosis of CuTS varies from surgeon to surgeon.

Conclusion

Our study presents a unique comparison of SD and SAT in a high-demand, physically active population, focused on patient-centered outcome scores, with 6-year follow-up. Analogous to the civilian reports, military patients undergoing SD and SAT had similar outcomes and complication rates. We believe that SAT has no benefit over SD in routine index surgical treatment of CuTS.

Disclaimer

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