



# Prospective evaluation of sleep improvement after cubital tunnel decompression surgery



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**Background:** Compromised sleep is a known phenomenon with compressive neuropathies such as carpal tunnel syndrome. However, the prevalence of sleep disturbance with cubital tunnel syndrome (CuTS) and the effect on sleep after ulnar nerve decompression are not well understood. We hypothesized that CuTS results in sleep disturbances and that decompression surgery would result in improvement in overall sleep quality.

**Methods:** Consecutive patients with electrodiagnostic-proven CuTS indicated for decompression were prospectively enrolled. Demographic data, McGowan grade, electrodiagnostic (electromyography) severity, visual analog scale pain score, the 11-item version of the Disabilities of the Arm, Shoulder and Hand questionnaire, and the Insomnia Severity Index scale data were collected preoperatively and at 2 weeks and 3 months postoperatively.

**Results:** There were 145 patients enrolled, with 97% available at 2 weeks and 72% available at the final 3-month follow-up. Surgical decompression procedures consisted of 102 in situ releases and 43 transpositions. The average preoperative Insomnia Severity Index score for the entire cohort was 10.7, above the threshold for a diagnosis of insomnia, which subsequently improved to 4.1 by final follow-up postoperatively, consistent with resolution of the insomnia. There was no difference in the extent of sleep improvement between in situ decompression and transposition. Similarly, electromyography severity and McGowan grade also did not appear to significantly affect the extent of sleep improvement.

**Conclusion:** CuTS decompression surgery, irrespective of surgical type and preoperative severity, resulted in improvement in sleep by the 3 month postoperative visit.

**Level of evidence:** Level IV; Case Series; Treatment Study

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Poor sleep affects overall patient health and accounts for socioeconomic costs from reduced daytime functionality and health-related costs.<sup>2,5,6,17</sup> Sleep disturbance is a common symptom of patients with upper extremity disorders, and information regarding the effect of surgical interventions may lead to overall disability improvement and patient satisfaction. Although the relationship between sleep and upper extremity disability is complex, psychosocial factors popular

in patient-reported outcome measures, including pain interference and adaptiveness, may be affected by poor sleep and vice versa.<sup>3,14</sup> In animal models, sleep deprivation is linked to an increase neuropathic pain with median nerve injury.<sup>6</sup> Considering all this, the effects of sleep disturbance are relevant to both patients and surgeons.

Sleep disturbance has been well studied in carpal tunnel syndrome, but there is no literature relating sleep disturbance in cubital tunnel syndrome (CuTS) or the effect of decompressive surgery on sleep quality.<sup>2,3,13,18</sup>

A direct correlation has been found between functional impairment from carpal tunnel syndrome and poor sleep, with as many as 78% of carpal tunnel syndrome patients having poor sleep.<sup>13</sup> Tulipan et al<sup>18</sup> evaluated the effects of carpal tunnel syndrome and subsequent decompression on sleep quality. Mean outcome scores for patients with carpal tunnel syndrome met the threshold for a clinical diagnosis of insomnia. Patients demonstrated improvement in the Insomnia Severity Index (ISI) and the 11-item version of the Disabilities of the Arm, Shoulder and Hand Questionnaire (*QuickDASH*).

To better understand the relationship between CuTS and sleep, a prospective study was conducted to determine the presence of any sleep disturbance and the effect of decompression on sleep quality. The primary study hypothesis was that CuTS would result in sleep disturbance as measured by preoperative ISI scores. The secondary study hypothesis was that CuTS decompression surgery would result in improved sleep quality by 3 months.

## Materials and methods

A prospective cohort study was performed. All patients undergoing cubital tunnel release surgery were consecutively and prospectively enrolled. Inclusion criteria included age older than 18 years, a clinical diagnosis of CuTS, and offered open surgery with in situ ulnar nerve release or transposition. Exclusion criteria included ulnar nerve decompression with or after acute elbow trauma and endoscopic cubital tunnel release. The participating surgeons indicated patients for decompression surgery based on clinical examination, electrodiagnostic findings, and discussion of surgical and nonsurgical treatment options.

Demographics and insurance data were collected. *QuickDASH* questionnaires and visual analog scale (VAS) pain scores were collected at time of enrollment preoperatively when the decision was made for surgery and then at every postoperative visit. A preoperative McGowan grade was determined by the treating surgeon preoperatively. Purely sensory symptoms without motor weakness was given a grade of I, sensory loss and weakness of intrinsic hand muscles without atrophy was given a grade of II, and both sensory loss and intrinsic muscle wasting was given a grade of III.<sup>11</sup>

The ISI is a validated and reliable questionnaire to evaluate sleep disturbance in research (Fig. 1).<sup>1,12,18,20</sup> The scale includes 7 categories of sleep: (1) difficulty falling asleep, (2) difficulty staying asleep, (3) problems waking up too early, (4) satisfaction with sleep pattern, (5) noticeability of sleep disturbance by others, (6)

distress from sleep pattern, and (7) effect of sleep pattern with daily living, including memory, mood, and concentration. Patients answer these question on a scale of 1 (no symptoms) to 4 (severe symptoms). A total score of 10 points is considered a threshold for insomnia.<sup>12</sup> A decrease of 6 points or more represents a clinically important difference.<sup>20</sup>

All operations were performed by fellowship-trained orthopedic hand surgeons (J.A., G.G., C.J., W.K., F.L., M.R., R.R.T., M.W., and A.M.I.) on an outpatient basis. Patients underwent in situ ulnar nerve decompression or transposition subcutaneously or submuscularly according to clinical examination and surgeon discretion. After being enrolled preoperatively when the patient consented for surgery, all patients were evaluated postoperatively, at 2 weeks, and 3 months for re-evaluation and complete questionnaires. Scores on *QuickDASH*, ISI, and VAS were tabulated, and statistical analysis was performed.

To determine whether there was significant improvement over time, repeated-measures analysis of variance via mixed models was conducted with a main effect for time for *QuickDASH*, ISI, and VAS of pain scores separately. The repeated-measures analysis of variance analysis was rerun including a main effect for time and McGowan stage, EMG severity, surgery type, and insurance, as well as their interaction. The model was adjusted for group baseline differences. All significant effects were followed by Bonferroni-corrected post hoc tests for the number of comparisons. Results were considered significant at  $P < .05$  (2-tailed) and marginally significant at  $P < .10$ . Finally, square root values were used in all mixed model analysis to normalize scores. Raw scores are presented. All analyses were conducted using SPSS 23 software (IBM, Armonk, NY, USA).

## Results

The study enrolled 145 patients undergoing CuTS decompression procedures. The patients (58% women, 42% men) were a mean age of 55 years (range, 22-88 years). The procedures in 23 patients (15.6%) were workers' compensation (WC) insurance cases. The decompression surgery technique used consisted of 102 in situ releases (70%) and 43 (30%) transpositions. Postoperatively, 97% of patients were available at 2 weeks, and 72% were available at the final 3-month follow-up visit.

Subgroup analysis of ISI scores is provided in Table I. The average preoperative ISI for the entire cohort was 10.7, above the threshold for a diagnosis of insomnia, and significantly improved postoperatively from baseline to 7.6 at 2 weeks and to 4.1 at 3 months ( $P < .001$ ). Clinically important improvement of at least 6 points occurred by the 3-month follow-up, ultimately resulting in resolution of preoperative insomnia. There was no significant difference between in situ decompression and transposition on ISI scores ( $P = .528$ ). Preoperative EMG severity and McGowan grade did not affect ISI scores. The WC insurance patients reported higher average preoperative ISI scores than the average for the entire cohort (13.1 vs. 10.7). WC patients also reported marginally higher average ISI scores at all assessments than the average for the entire cohort ( $P = .09$ ) and showed less improvement.

The Insomnia Severity Index has 7 questions. The 7 answers are added up to get a total score. When you have your total score, look at the "Guidelines for Scoring/Interpretation" below to see where your sleep difficulty fits.

For each question, please CIRCLE the number that best describes your answer.

Please rate the CURRENT (i.e., LAST 2 WEEKS) SEVERITY of your insomnia problem(s).

Insomnia Problem	None	Mild	Moderate	Severe	Very Severe
1. Difficulty falling asleep	0	1	2	3	4
2. Difficulty staying asleep	0	1	2	3	4
3. Problems waking up too early	0	1	2	3	4

4. How SATISFIED/DISSATISFIED are you with your CURRENT sleep pattern?  
 Very Satisfied 0    Satisfied 1    Moderately Satisfied 2    Dissatisfied 3    Very Dissatisfied 4
5. How NOTICEABLE to others do you think your sleep problem is in terms of impairing the quality of your life?  
 Not at All Noticeable 0    A Little 1    Somewhat 2    Much 3    Very Much Noticeable 4
6. How WORRIED/DISTRESSED are you about your current sleep problem?  
 Not at All Worried 0    A Little 1    Somewhat 2    Much 3    Very Much Worried 4
7. To what extent do you consider your sleep problem to INTERFERE with your daily functioning (e.g., daytime fatigue, mood, ability to function at work/daily chores, concentration, memory, mood) CURRENTLY?  
 Not at All Interfering 0    A Little 1    Somewhat 2    Much 3    Very Much Interfering 4

Guidelines for Scoring/Interpretation:

Add the scores for all 7 items (questions 1 + 2 + 3 + 4 + 5 + 6 + 7) = \_\_\_\_\_ your total score

Total score categories:  
 0–7 = No clinically significant insomnia  
 8–14 = Subthreshold insomnia  
 15–21 = Clinical insomnia (moderate severity)  
 22–28 = Clinical insomnia (severe)

Figure 1 Insomnia Severity Index.

Subgroup analysis of *QuickDASH* scores is provided in Table II. The average preoperative *QuickDASH* score was 41.4 for the cohort. Scores increased at the 2-week visit to 45.5 and improved at 3 months to 20.5, at which point the improvement was significant ( $P < .001$ ). The difference in improvement between in situ vs. transposition on *QuickDASH* scores was not significant ( $P = .682$ ). There was no significant interaction of EMG severity ( $P = .695$ ) or of McGowan grade ( $P = .795$ ) on *QuickDASH* scores. WC patients reported higher preoperative *QuickDASH* scores of 45.7 and also reported marginally higher average *QuickDASH* scores at all assessments than the average for the entire cohort ( $P = .076$ ).

Subgroup analysis of VAS pain scores is provided in Table III. The average preoperative pain score was 4.45, improved at 2 weeks, and further improved at 3 months to 1.7 ( $P < .003$ ). There was no difference between in situ decompression vs. transposition on pain scores ( $P = .560$ ). There was no significant interaction of EMG severity ( $P = .964$ ) or of McGowan grade on pain scores ( $P = .143$ ).

There was no significant interaction of WC status on pain scores ( $P = .848$ ).

## Discussion

Sleep disturbance is a well-known phenomenon with carpal tunnel syndrome and CuTS. Carpal tunnel syndrome symptoms are aggravated during sleep and are known to disturb sleep.<sup>10,19</sup> A previous study by this group demonstrated the relationship between insomnia and carpal tunnel decompression surgery.<sup>18</sup> In that study, preoperative ISI scores met thresholds for insomnia and improved to normal limits, with clinically important difference occurring by the 2-week postoperative visit.

Rubin et al<sup>15</sup> performed a controlled comparison study of carpal tunnel syndrome patients undergoing nighttime bracing and decompressive surgery. The results revealed improvement in ISI scores with both nighttime bracing and surgery, but surgery yielded greater improved ISI scores compared with

**Table I** ISI scores preoperatively, postoperatively, and at 3-month intervals

Variable	Pre-op	No.	First POV	No.	3 mo	No.	P
All*	10.63	128	7.60	112	4.13	78	<.001
Decompression†	10.81	91	7.89	80	3.98	54	.528
Transposition†	10.47	34	7.03	31	4.46	24	
Electromyography							
Mild‡	11.71	17	8.94	17	3.10	10	.635
Moderate‡	11.51	53	8.47	45	5.47	30	
Severe‡	8.67	42	6.03	38	3.39	31	
McGowan grade							
I§	11.46	41	7.87	39	3.76	25	.143
II§	12.23	48	10.53	38	5.44	27	
III§	6.76	29	2.77	26	3.20	20	
WC	13.21	19	9.61	18	4.83	12	.168
Non-WC	10.09	86	6.89	73	4.32	50	

ISI, Insomnia Severity Index; POV, postoperative visit; WC, workers' compensation.

\* P values are reported for the main effect of time on ISI scores.

† P values are reported for the main effect of in situ decompression vs. transposition over time.

‡ P values are reported for the main effect of electromyography severity (mild vs. moderate vs. severe) over time.

§ P values are reported for the main effect of McGowan grade (I vs. II vs. III) over time.

|| P values are reported for the main effect of insurance type (WC insurance vs. non-WC insurance) over time.

**Table II** QuickDASH scores preoperatively, postoperatively, and at 3-month intervals

Variable	Pre-op	No.	First POV	No.	3 mo	No.	P
All*	41.38	138	45.47	105	20.84	77	<.001
Decompression†	41.16	95	47.11	73	18.50	51	.682
Transposition†	43.06	39	42.67	31	25.50	26	
Electromyography							
Mild‡	38.24	17	47.83	16	19.75	10	.695
Moderate‡	40.63	56	45.86	39	18.34	30	
Severe‡	42.19	48	42.96	38	23.14	31	
McGowan grade							
I§	37.84	44	44.82	33	21.06	24	.755
II§	45.93	53	49.86	40	21.64	25	
III§	38.69	30	38.03	25	20.49	22	
WC	45.70	21	49.06	18	28.15	15	.895
Non-WC	39.49	90	43.02	70	18.70	46	

QuickDASH, 11-item version of the Disabilities of the Arm, Shoulder and Hand; POV, postoperative visit; WC, workers' compensation.

\* P values are reported for the main effect of time on QuickDASH scores. Post hoc tests indicate that there was no difference between preoperative and first postoperative intervals but significant difference between postoperative and 3-month intervals.

† P values are reported for the main effect of in situ decompression vs. transposition over time.

‡ P values are reported for the main effect of electromyography severity (mild vs. moderate vs. severe) over time.

§ P values are reported for the main effect of McGowan grade (I vs. II vs. III) over time.

|| P values are reported for the main effect of insurance type (WC insurance vs. non-WC) over time.

bracing. For similar reasons, sleeping positions may exacerbate CuTS and interfere with regular sleep patterns, leading to insomnia. Whereas the effect is well studied in carpal tunnel syndrome, less is known about the effects of CuTS on sleep patterns.<sup>3,13,18</sup>

Currently, there is no published research that describes the effects of CuTS decompression surgery on sleep patterns. In this study, we hypothesized that patients with CuTS would experience significant sleep disturbance and that sleep quality would improve after cubital tunnel decompression. We analyzed patient sleep patterns using a validated and reliable insomnia questionnaire to demonstrate the effect of CuTS on sleep. Average ISI scores improved from a preoperative threshold for "insomnia" to values considered "normal sleep" postoperatively. Clinically important sleep improvement was seen at 3 months postoperatively, although mean scores also significantly improved even at 2 weeks.

Sleep improvement occurs within 2 weeks after carpal tunnel release but occurs later after cubital tunnel decompression surgery.<sup>18</sup> The improvement coincided with improvements in pain and QuickDASH scores at the final follow-up, indicating overall improvement in disability after decompression surgery. Patients with worse preoperative EMG severity or McGowan grade did not experience more sleep disturbance. This is consistent with previous studies of EMG and McGowan grades failing to predict CuTS outcomes.<sup>3,14</sup>

Although the average ISI and pain scores improved at each postoperative visit, the average QuickDASH scores did not significantly improve until the 3-month postoperative period. This finding can be explained by the functional limitations of the postoperative state and the postoperative dressing and immobilization, such as difficulty washing the back and recreational use. The benefit of ulnar nerve decompression may require longer than 2 weeks to truly manifest. Indeed, scores improved by more than 20 points at final follow-up, indicating a meaningful improvement in upper extremity disability with CuTS decompression surgery.<sup>3</sup> VAS pain scores significantly improved for the cohort at the 2-week assessment and further improved at 3 months.

The surgery type did not significantly affect QuickDASH, VAS pain, or ISI scores, consistent with meta-analyses comparing outcomes of in situ vs. transposition ulnar nerve decompression.<sup>8,21</sup> Henn et al<sup>16</sup> similarly found no significant difference in VAS pain score improvement between in situ decompression and transposition when indicated in young patients.

WC patients demonstrated less improvement in mean ISI and QuickDASH compared with the entire cohort, but pain scores did not differ significantly. Mean preoperative values of ISI and QuickDASH were all greater than mean scores for the entire cohort preoperatively. Although the sample size of

**Table III** Pain scores preoperatively, postoperatively, and at 3-month intervals

Variable	Pre-op	No.	First POV	No.	3 mo	No.	<i>P</i>
All*	4.43	122	2.49	108	1.73	80	<.001
Decompression†	4.49	83	2.66	77	1.68	57	.560
Transposition†	4.40	35	2.14	29	1.83	23	
Electromyography							
Mild‡	4.44	16	2.56	18	2.18	11	.864
Moderate‡	4.64	50	2.91	43	1.97	33	
Severe‡	4.00	42	2.06	34	1.19	31	
McGowan grade							
I§	4.59	37	2.15	34	2.00	26	.234
II§	4.87	45	3.25	40	2.21	28	
III§	3.52	29	1.50	24	0.70	20	
WC	4.50	16	2.86	14	1.92	12	.848
Non-WC	4.36	81	2.29	73	1.69	52	

POV, postoperative visit; WC, workers' compensation.

\* *P* values are reported for the main effect of time on pain scores.

† *P* values are reported for the main effect of in situ decompression vs. transposition over time.

‡ *P* values are reported for the main effect of electromyography severity (mild vs. moderate vs. severe) over time.

§ *P* values are reported for the main effect of McGowan grade (I vs. II vs. III) over time.

|| *P* values are reported for the main effect of insurance type (WC insurance vs. non-WC insurance) over time.

this subgroup is small, this finding is consistent with other studies, including those involving carpal tunnel and cubital tunnel decompression surgery.<sup>4,7</sup>

Another finding is the late presentation of CuTS. Most patients had developed intrinsic weakness indicated by McGowan grades II or III (*n* = 83) vs. McGowan grade I (*n* = 44). This is consistent with reports in the literature that CuTS presents with muscle atrophy, whereas carpal tunnel syndrome generally presents earlier.<sup>9</sup>

This study has several limitations. First, patients may be susceptible to recall bias.

Second, the study did not control for comorbidities potentially affecting sleep patterns, including obstructive sleep apnea and diabetes.

Third, transposition surgery was not subcategorized for subcutaneous or submuscular transposition, and sample sizes were not evenly distributed between in situ decompression and transposition.

Fourth, although the 2-week follow-up was 97%, follow-up at 3 months was only 72%. This is likely related to patients' reluctance to follow-up at this period.

Areas for future research are the application of the ISI score to other upper extremity conditions affecting sleep and assessing whether sleep quality may be incorporated in patient-reported outcome measures.

Strengths of this study include the prospective data collection of a large cohort. A validated sleep assessment tool was used to demonstrate sleep improvement. Operations were

performed by 9 high-volume hand surgery fellowship-trained orthopedic surgeons, further enhancing the external validity of the results. Lastly, the results are in agreement with previous studies, including the effects of sleep on compression neuropathies.

The findings in this study indicate that CuTS may cause clinically significant insomnia and that sleep patterns can be improved to normal sleep by decompressive surgery by 3 months postoperatively. Decompressive surgery type, EMG severity, and McGowan grade did not correlate with the extent of sleep recovery. In addition, most patients had intrinsic weakness (McGowan grade II or III), indicating that CuTS presents at an advanced stage.

## Conclusion

Patients undergoing CuTS decompression surgery, irrespective of surgical type and preoperative severity, experienced an improvement in sleep quality from a preoperative characterization of insomnia to normal sleep postoperatively by the 3-month postoperative visit.

## Disclaimer

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