Annals of Clinical and Analytical Medicine
Original Research

Temporary splint application in extension to prevent ulnar nerve instability after in situ release

Splint application in extension for ulnar nerve instability

Ömer Ayık[1], Ümit Aygün[2], Murat Altan[3], Soner Özcan[1]
[1] Department of Orthopaedics and Traumatology – Hand Surgery, Erzurum Regional Training and Research Hospital, Erzurum
[2] Department of Orthopaedics and Traumatology, Faculty of Medicine, Istinye University, VM Medical Park Samsun Hospital, Samsun
[3] Department of Orthopaedics and Traumatology, Sarıkamış State Hospital, Kars, Turkey

Abstract
Aim: There is still no definitive consensus on cubital tunnel syndrome (CuTS) surgery, for which various surgical methods have been described. Simple in situ release (ISR) is preferred in primary CuTS due to the disadvantages of the anterior transposition (AT) technique, such as being more invasive, more extended surgery duration, particularly devascularization, worsening nerve function, or wound problems. Nevertheless, instability is occasionally observed when the ulnar nerve comes out of its groove during elbow movements after ISR. In this case, a blocking flap or AT is recommended to protect the nerve in situ. The present study aims to present the clinical results of temporary extension splint application applied to maintain the ulnar nerve in its groove in patients with instability noticed after ISR surgery.
Material and Methods: Twenty-two patients with a mean age of 46 years diagnosed with primary CuTS were included in the study. All patients were provided with an extension splint for two weeks and a commercial cubital tunnel extension splint for two weeks. The mean follow-up time was 20 months.
Results: Clinical outcomes such as Visual Analog Score (VAS), Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire, pinch strength, grip strength, 2-point discrimination, recovery of motor functions, and functional and aesthetic satisfaction were positive. Only one patient (4.5 %) required secondary surgery.
Discussion: The simple, temporary extension splinting method is an effective way to address instability that may develop after ISR that is neither time-consuming nor more invasive.

Keywords
Cubital Tunnel Syndrome, In Situ Release, Extension Splint, Instability

DOI: 10.4328/ACAM.21250 Received: 2022-05-29 Accepted: 2022-06-29 Published Online: 2022-07-08 Printed: 2022-11-01 Ann Clin Anal Med 2022;13(11):1205-1209
Corresponding Author: Ümit Aygün, Department of Orthopaedics and Traumatology, Faculty of Medicine, Istinye University, VM Medical Park Samsun Hospital, Samsun, Turkey.
E-mail: aygun.umit@yahoo.com, aygun.umit55@gmail.com P: +90 505 558 13 21
Corresponding Author ORCID ID: https://orcid.org/0000-0001-7234-1654

Introduction

Cubital tunnel syndrome (CuTS) is the second most common entrapment neuropathy and can be classified as either primary (idiopathic) or secondary (deformation, previous surgery, mass) according to its etiology [1]. Mechanisms such as compression, traction, and friction are responsible for its pathophysiology [1,2]. Conservative treatment is initially recommended for patients with symptoms consistent with CuTS, and surgical methods are used only in patients with no positive response. Diverse surgical procedures such as in situ release (ISR), anterior transposition (AT), and medial epicondylectomy (ME) have been developed; however, there is no traditional gold standard technique. Largely similar outcomes have been obtained with these techniques, as described in many comparative studies [3]. When the advantages and disadvantages are evaluated, the current tendency is toward ISR, a simple, effective, low-morbidity procedure [4]. Elbow hyperflexion, ulnar nerve instability, and anterior subluxation have been observed in patients who underwent ISR due to traction and tension, which are responsible for the etiology of CuTS. The sequelae of an unstable ulnar nerve are associated with surgical failure and persistent neuropathy and often require revision surgery [5]. Nonetheless, it remains unclear how best to manage the unstable ulnar nerve after in situ decompression. Potential remedies include creating a new blocking flap and anterior transposition to protect the nerve in situ [6,7].

In this study, a more straightforward, practical method for ulnar nerve instability, as detected during preoperative elbow hyperflexion examination, following ISR temporary splinting, is applied as an extension where the nerve remains in the correct anatomical position to preserve the clinical consequences of this method.

Material and Methods

Approval was acquired from the local institutional ethical committee, and written informed consent was obtained from all patients. Patients who presented to a single tertiary referral hospital with CuTS between January 2017 and January 2020 were included. Since only primary CuTS patients were included in the study, patients with a history of fracture in the elbow region, varus-valgus deformity of the elbow, compression due to a mass, bilateral subluxation before surgery, and an additional diagnosis of another entrapment neuropathy or surgical release were excluded from the study.

Technique

Following the application of an Esmarch bandage from the proximal humerus under regional block or general anesthesia, the preoperative preparation of the patients was conducted under shoulder hyperabduction and 90° flexion of the elbow. After making an incision of approximately 10-12 cm passing through the center of the olecranon with the medial epicondyle, the medial antebrachial cutaneous nerve branch was exposed and preserved. The ulnar nerve was exposed proximally, as this is more comfortable, and the medial intermuscular septum and Arcade of Struthers, both potential entrapment areas, were released. Then, distally, Osborne's ligament and the flexor-pronator aponeurosis were released. The nerve was retained in its bed and not circumferentially dissected by the surrounding connective tissue. After all releasing procedures were completed, the elbow was flexed, and the presence of nerve instability was assessed (Figures 1-2).

In anterior dislocations, the procedure was completed by applying a splint at an extension angle of approximately 120-130° that allows wrist movement after the wound closes (Figure 3).

Postoperative Management

The patients were discharged on the same day with oral analgesics. A dressing change was recommended every 3-4 days. Active-passive elbow full extension and elbow flexion up to 90° and unrestricted supination-pronation movements were performed at each dressing change. After approximately two weeks, the sutures and splint were removed, and a cubital tunnel splint was initiated. During the day, the splint was released twice, and passive-active elbow movements were performed in which the patients did not exceed 90° of flexion. After two weeks, the cubital tunnel splint application was terminated, and elbow movements were allowed without restriction. No special rehabilitation program was applied to any patient except for the recommended passive and active elbow movements after surgery.

Clinical Assessment

An independent hand surgeon who did not attend to any of the operations conducted the final follow-up assessment. Medical records were evaluated retrospectively. Upon inspection, intrinsic muscle weakness in hands was classified using the modified McGowan [8] classification system. According to this classification, the claw of small finger, inability to cross-index and middle fingers, positive Froment test, and Wartenberg sign were classified as central intrinsic atrophy. The inability to cross the index and long fingers was classified as a positive Froment test, and the Wartenberg sign was classified as moderate atrophy. The hand without signs of intrinsic atrophy was considered normal. The Tinel test, provocation of pain with the elbow flexion test, and pain levels were evaluated with a visual analog score (VAS). Functional status was assessed with the Quick-Disabilities of the Arm, Shoulder, and Hand (Q-DASH) questionnaire. In all patients, the preoperative and postoperative findings were compared.

The postoperative elbow range of motion (ROM), two-point discrimination (2PD), pinch, and grip strength of the patients were compared with the contralateral side and represented as a percent (%). Elbow flexion-extension ROMs were measured with a goniometer. The ulnar nerve flexion compression test is considered positive if there is numbness, tingling and pain in the ulnar nerve distribution when the elbow is in maximum flexion and supination for 60 seconds. Two-point discrimination (2PD) was measured in the flap area where the best response is taken and in the fifth finger using Baseline® plastic 2PD instrument (Baseline, White Plains, NY, USA). The key-pinch and grip strengths were measured with a Jamar Hydraulic Hand Dynamometer™ and Pinch Meter (Sammons Preston, Bolingbrook, IL, USA), and the mean of three trials was utilized for data analysis.

Patients with pre- and postoperative functional satisfaction and signs of motor atrophy were graded as very disappointed, disappointed, somewhat satisfied, satisfied, or very satisfied

in terms of the change in hand aesthetics. The return of the patients to their job was recorded. During elbow hyperflexion, subluxation of the ulnar nerve was noted with palpation.

Statistical Analysis

IBM SPSS Statistics software version 28.0 (IBM Corp., Armonk, NY, USA) was used for the statistical analyses. Mean, median, standard deviation, maximum and minimum were used as descriptive statistical methods. The normality of the distribution was tested using the Shapiro-Wilk's test. The Wilcoxon signed-rank test was applied to groups with non-normal distribution, whereas the paired t-test was used to compare dependent groups. The chi-square test was used to compare the groups with respect to categorical variables. A p-value of less than 0.05 was accepted as statistically significant.

Results

The mean age of 22 patients (12 males, 10 females) was 46.1 years (range: 26 - 72); 12 right, 10 left, and dominant arm involved 13 patients. The mean time to onset of symptoms was 11.8 months (range: 6 - 26), and the mean follow-up time after surgery was 20 months (range: 12 - 32). According to the modified McGowan classification, 4 patients were Type I, 3 were Type IIA, 9 were Type IIB, and 6 were Type III. According to the electromyographical (EMG) examination, 3 patients were mild, 10 were moderate, 8 were severe, and 1 had no pathological EMG findings. In the inspection, 6 patients had major atrophy,

Table 1. Clinical outcomes of the patients in the preoperative and postoperative periods

		Preoperative	Postoperative
mMGC*	I	4	-
	IIA	3	
	IIB	9	
	III	6	
EMG**	Mild	3	-
	Moderate	10	
	Severe	8	
Atrophy	None	7	17
	Moderate	9	3
	Major	6	2
Positive Tinnel Test		18	2
Positive Elbow Flexion Test		22	0
VAS*** (range: min max) (p value)		6,4 (range: 5-8)	0.63 (range: 0-2) (p<0,05)
Q-DASH****		40.8 (range: 31,8 – 52,5)	4.2 (range: 0 – 13,6) (p<0,05)
Total ROM° Contralateral side Different % Mean (min-max)		-	2 (0 – 10)
2 PD***** Contralateral side % Mean (min-max)		-	120 (100- 160)
Pinch strength Contralateral side % Mean (min-max)		-	92 (range: 80-110)
Grip strength Contralateral side % Mean (min-max)		-	92.3 (range: 85-110)
Functional satisfaction (22 patients)	-Very satisfied	-	17
	-Satisfied	-	4
	-Somewhat satisfied	-	-
	-Disappointed	8	1
	-Very disappointed	14	-
Aesthetic satisfaction (15 patients)	-Very satisfied	-	5
	-Satisfied	-	4
	-Somewhat satisfied	-	1
	-Disappointed	5	2
	-Very disappointed	10	3

* Modifiye McGowan Classification, ** Electromyography, *** Visual Analogue Score, ****Quick -Disabilities of the Arm, Shoulder, and Hand Questionnaire, ***** Two-Point Discrimination

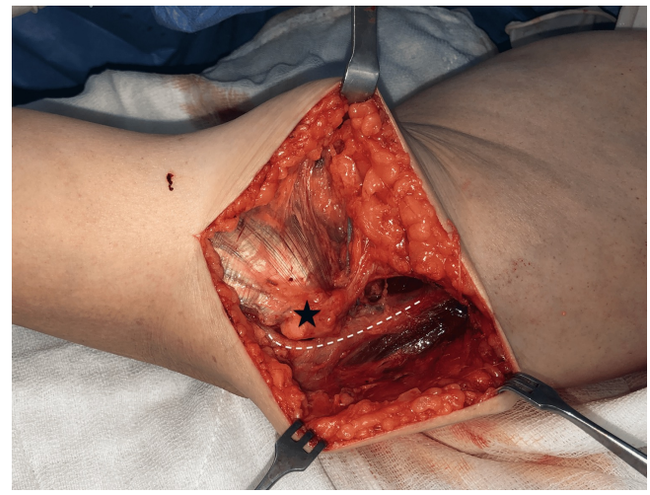

Figure 1. Placement of the nerve in the ulna groove with the extension of the elbow, following in situ release.
White dashed line: Ulnar nerve; ★: Medial epicondyle

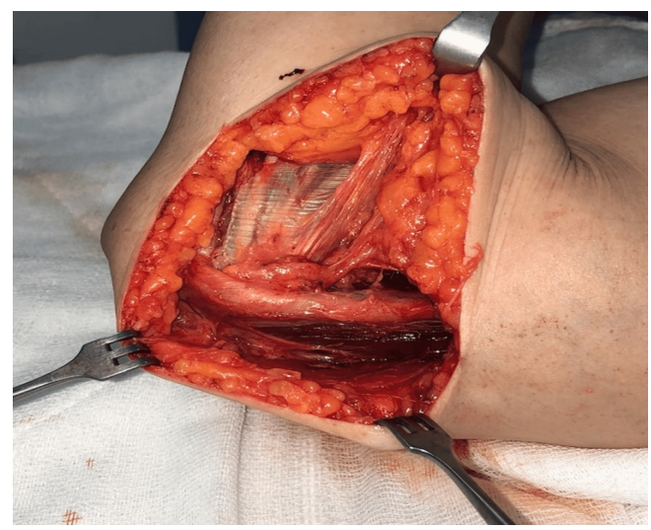

Figure 2. Over the medial epicondyle, ulnar nerve after in-situ release, while the elbow is in flexion

Figure 3. Long arm splint in semi-extension position

9 had moderate atrophy findings, and 7 had no internal atrophy findings. Tinel's sign was positive in 18 patients, and the elbow flexion test was positive in all patients. Routinely, all patients received a similar conservative treatment consisting of oral anti-inflammatory drug therapy, movement modification, and a night splint for three months. Patients who did not respond adequately to conservative treatment were recommended for surgery.

The mean VAS score significantly improved from 6.4 (range: 5 - 8) to 0.63 (range: 0 - 2) ($p < 0.001$). The mean quick-DASH significantly improved from 40.8 (range: 31.8 - 52, 5) preoperatively to 4.2 (range: 0 - 13.6) at the final follow-up ($p < 0.001$). Postoperative Tinel's sign was positive in 2 patients. The elbow flexion test was negative in all patients postoperatively. Compared with the other elbow, the distinction in total elbow ROM was negligible (2% difference). Compared with the contralateral side, patients had an average of 92% (range: 80 - 110) pinch strength and 92.3% (range: 85 - 110) grip strength. Compared with the five fingertips of the opposite hand, 2PD was observed to increase by 130% (range: 100 - 160). These results are similar to published studies evaluating the results of ulnar nerve functions [9]. While 3 of the 6 patients with major atrophy showed improvement, 7 of the 9 patients with moderate atrophy showed improvement. One patient with major atrophy improved to moderate atrophy.

Functionally, before the surgery, 14 patients were very disappointed, and 8 were disappointed; after the surgery, 17 were very satisfied, 4 were satisfied, and 1 was disappointed. Of the 15 patients (9 moderate, 6 major) whose aesthetic satisfaction was questioned preoperatively due to signs of motor atrophy in their hands, 10 were very disappointed, and 5 were disappointed. Postoperatively, 3 patients were very disappointed, 2 were disappointed, 1 somewhat satisfied, 4 satisfied, and 5 very satisfied. All patients returned to their jobs (Table 1) (Figures 1-3).

Complications

After 4 weeks of splint application, instability with elbow hyperflexion was observed in only one (4.5%) male patient. This was expressed as a painful snapping sensation felt with palpation. Improvement was observed following anterior transposition with secondary surgery. Local wound problem was observed in one patient, and complete healing was achieved with oral antibiotic therapy and dressing.

Discussion

Despite being quite common, the treatment of CuTS remains under debate. Although ISR is preferred for primary CuTS surgery, AT is applied widely. In ISR, only the sheath and fascia above the nerve are released, while the nerve remains in its bed. In contrast, the AT procedure involves circular release of the nerve from the medial condyle to approximately 5-6 cm proximal and 5-6 cm distal and moving it to a new bed [10]. This comprehensive release technique comes with some complications. As is known, nerves are fed externally and internally [11]. Since the ISR is left in the nerve bed, its external nutrition is broadly preserved. In AT, on the other hand, approximately 10-12 cm of circular release process leads to a loss of external circulation in this segment, the risk of nerve devascularization, and segmental necrosis [2,12].

Contrary to this view, in the immediate postoperative period after AT, there may be a relative increase in blood flow, which significantly reduces within 3-7 days [13]. In addition to this complication of the AT procedure, which is even discussed and unclear, there is also the risk of increasing scar formation in the new bed [14]. With ISR, the external circulation of the nerve preserved in its bed is less affected, and the surrounding scar formation is minimized.

Some primary CuTS have instability during ISR surgery. Matzon et al. reported an instability rate of 12% in their study [14]. In this case, there are also statements suggesting the AT technique along with techniques that include creating a blocking flap that protects the nerve in its bed [2,4]. Since both procedures require further surgery, we aimed to protect the ulnar nerve in its bed with a non-invasive, low-morbidity splint technique. This technique includes preventing nerve instability by the formation of some pseudo-sheath. As such, instability only persisted in one patient (8%), and AT was applied secondarily. Based on our clinical results, it can be concluded that this method is effective, with a 92% success rate.

The main population of this study consisted of patients with subluxation after ISR. How much nerve subluxation will lead to problems has not been determined in the literature. The first objective classification on this subject was developed by Tang. They recommend the blocking flap technique for early-stage instability, while AT was recommended for gross instability [6]. In this study, instability grading was not performed, and the presence of instability was assumed as anterior dislocation of the nerve out of the ulnar groove and over the medial epicondyle with elbow flexion over 90° during the examination, and AT was not applied in any of the patients.

Surgical time was not evaluated in this study, but our technique has the advantage of creating a new blocking flap in less time than AT, except for an additional splint of 3-5 minutes. The most pertinent limitation of our approach is that the application of a splint for approximately 1 month can be irritating for the patients and may limit movement. No restriction of motion was observed in any of our patients. We attribute this to the fact that splint application was not continued for long enough to develop movement restriction, and passive elbow movements were performed intermittently during dressing changes. A large series study investigating the risk factors for ulnar nerve instability found that the male sex and younger age might cause stronger tricep contraction and, therefore, may be the strongest predictor of instability [14]. In this study, 12 out of 22 patients were male, and the mean age was 46 years. Our results do not support that the male sex and younger age have a higher risk.

This study has some limitations such as its retrospective nature, the limited number of patients for this common surgical pathology, and short- to medium-term follow-up results. Providing long-term results with a larger number of patients will contribute more to the field.

Conclusions

In CuTS, which is particularly common and contains debates that have not yet been clarified, the most preferred surgical method is in situ release, while AT with higher complications is preferred

less frequently. In the frequent surgical treatment of CuTS, AT is less preferred because it is more prone to complications. For ulnar nerve instability seen following ISR, it is a method that we could recommend in the light of the positive clinical results we have obtained with temporary extension splinting in temporary extension that does not require additional surgical intervention, despite some techniques that protect the nerve in place or AT recommendations in the literature. Temporary splint in extension as an alternative to AT in ulnar nerve instability following ISR is a practical method that generates positive results.

Scientific Responsibility Statement
The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement
All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

Funding: *None*

Conflict of interest
None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.

References
1. Assmus H, Antoniadis G, Bischoff C, Hoffmann R, Martini A-K, Preissler P, et al. Cubital tunnel syndrome - a review and management guidelines. Cent Eur Neurosurg. 2011;72(2):90-8.
2. Boone S, Gelberman RH, Calfee RP. The management of cubital tunnel syndrome. J Hand Surg Am. 2015;40(9):1897–904.
3. Zhang D, Earp BE, Blazar P. Rates of Complications and Secondary Surgeries After In Situ Cubital Tunnel Release Compared With Ulnar Nerve Transposition: A Retrospective Review. J Hand Surg Am. 2017;42(4):294.e1-5.
4. Soltani AM, Best MJ, Francis CS, Allan BJ, Panthaki ZJ. Trends in the surgical treatment of cubital tunnel syndrome: an analysis of the national survey of ambulatory surgery database. J Hand Surg Am. 2013;38(8):1551-6.
5. Krogue JD, Aleem AW, Osei DA, Goldfarb CA, Calfee RP. Predictors of surgical revision after in situ decompression of the ulnar nerve. J Shoulder Elbow Surg. 2015; 24(6):634-9.
6. Tang P. The Blocking Flap for Ulnar Nerve Instability After In Situ Release: Technique and a Grading System of Ulnar Nerve Instability to Guide Treatment. Tech Hand Up Extrem Surg. 2017;21(4):137-42.
7. Lane LB, Greenberg AS. Use of a Fascial Flap to Stabilize an Unstable Ulnar Nerve in Its Bed During In Situ Decompression. J Surg Orthop Adv. 2015;24(3):193-7.
8. Staples JR, Calfee R. Cubital Tunnel Syndrome: Current Concepts. J Am Acad Orthop Surg. 2017;25(10):e215-e24.
9. Harder K, Lukschu S, Dunda SE, Krapohl BD. Results after simple decompression of the ulnar nerve in cubital tunnel syndrome. GMS Interdiscip Plast Reconstr Surg DGPW. 2015; 4. DOI: 10.3205/iprs000078.
10. Palmer BA, Hughes TB. Cubital tunnel syndrome. J Hand Surg Am. 2010;35(1):153-63.
11. Shin R, Ring D. The ulnar nerve in elbow trauma. J Bone Joint Surg Am. 2007;89(5):1108-16.
12. Aleem AW, Krogue JD, Calfee RP. Outcomes of revision surgery for cubital tunnel syndrome. J Hand Surg Am. 2014;39(11):2141-9.
13. Ergin ON, Turgut N, Bayram S, Demirel M, Altan M, Salduz A, et al. Anterior transposition versus in situ neurolysis in cubital tunnel syndrome: a comparison based on functional and electro-diagnostic evaluation. J Ist Faculty Med 2020;83(3):204-8.
14. Matzon JL, Lutsky KF, Hoffler CE, Kim N, Maltenfort M, Beredjiklian PK. Risk Factors for Ulnar Nerve Instability Resulting in Transposition in Patients With Cubital Tunnel Syndrome. J Hand Surg Am. 2016;41(2):180-3.

How to cite this article:
Ömer Ayık, Ümit Aygün, Murat Altan, Soner Özcan. *Temporary splint application in extension to prevent ulnar nerve instability after in situ release. Ann Clin Anal Med 2022;13(11):1205-1209*