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Minimal-Incision In Situ Ulnar Nerve Decompression at the Elbow

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INTRODUCTION

Ulnar nerve entrapment at the elbow is the second most common compression neuropathy in the upper extremity following carpal tunnel syndrome,^{1,2} with an estimated prevalence of 1% in the US population.³ Although earlier descriptions of ulnar neuropathy at the elbow are found in the literature,^{4,5} the entity of *cubital tunnel syndrome* was originally proposed by Feindel and Stratford^{6,7} in 1958.

Although simple “liberation of the ulnar nerve” was performed as early as 1878,⁵ British surgeon Geoffrey Osborne would be the first to gain significant support for simple decompression of the nerve by dividing the eponymous ligament.² In his 1957 study,⁸ the fibrous connective tissue band spanning the interval between the medial epicondyle and the olecranon was divided. Osborne posited that, in patients with idiopathic ulnar neuropathy at the elbow, simple in situ decompression offered results similar to the more aggressive surgical techniques available.⁹

Trauma and arthritis have both been implicated as causes for ulnar neuropathy. Nevertheless, the most frequent cause of cubital tunnel syndrome remains idiopathic.² Multiple potential sites of compression exist along the path of the ulnar nerve. These sites include the arcade of Struthers, the medial intermuscular septum, the anconeus epitrochlearis muscle (if present), the cubital tunnel with the overlying ligament of Osborne, the flexor carpi ulnaris (FCU) muscle, and the flexor-pronator aponeurosis.^{10,11} Evidence has also shown that, with elbow flexion and extension, the ulnar nerve lengthens^{6,12,13} and is potentially compressed by both dynamic pressure^{6,14–17} and shape^{6,7,12,18,19} changes within the tunnel.

Cubital tunnel syndrome can be treated with a variety of surgical approaches, including simple in situ decompression, epicondylectomy, and various transposition techniques.^{2,20,21} Controversy remains, however, regarding the gold standard surgical approach²⁰ owing to the

relatively similar rates of operative successes and failures as well as strong proponents for each technique.^{8,22,23}

Since the term *minimally invasive surgery* was first coined by Wickham²⁴ in 1987, the length of surgical incisions and the extent of soft tissue dissection continue to decrease. Minimally invasive approaches for the treatment of cubital tunnel syndrome are becoming increasingly commonplace as evidence supporting the safety, efficacy, and lower relative morbidity of these procedures accumulates.^{25–27} Minimal-incision open in situ cubital tunnel release is discussed further in this article.

Anatomy

Originating from the ventral rami of the C8 and T1 nerve roots, the ulnar nerve is the terminal branch of the medial cord of the brachial plexus. The nerve courses anterior to the medial intermuscular septum, passing through the arcade of Struthers 8 cm proximal to the medial epicondyle. Continuing toward the elbow, the ulnar nerve travels alongside and just posterior to the septum, entering the cubital tunnel between the medial epicondyle and the olecranon. The floor of the cubital tunnel consists of the medial collateral ligament and the elbow joint capsule, and the roof is made of the Osborne ligament as well as the fascia of the FCU. The nerve then travels into the forearm between the humeral and ulnar heads of the FCU and continues in the interval between the FCU and the flexor digitorum profundus muscle bellies^{2,11} toward the wrist and hand.

SURGICAL TECHNIQUE

Preoperative Planning

The diagnosis of cubital tunnel syndrome requires a careful examination and history. Symptoms are typically a combination of numbness, weakness, and paresthesias in the ulnar nerve distribution. The initial examination should assess vibratory and light touch sensation in the ulnar distribution. More severe cases can also show abnormal 2-point discrimination, muscle wasting, intrinsic atrophy, and clawing. The examiner may also find positive Wartenberg and Froment signs in more advanced cases.^{2,28–36}

There are several provocative tests useful in localizing ulnar neuropathy at the elbow. Although up to 24% of asymptomatic individuals may manifest a positive finding,³⁷ a Tinel sign is commonly associated with cubital tunnel syndrome and has a 98% negative predictive value.^{38,39} Other sensitive and specific clinical findings include the elbow flexion, the cubital tunnel compression test,⁴⁰ and the scratch collapse test.¹ This test has recently been described whereby a brief loss of muscle resistance is elicited with skin scratching over the area of nerve compression as patients resist shoulder external rotation.¹ The scratch collapse test has a sensitivity of 69% and an accuracy of 89%.³⁹ An inching technique, though not mandatory in all patients, may be helpful to determine the exact location of compression.

Clinical evaluation is paramount in the diagnosis of cubital tunnel syndrome because electrodiagnostic testing is not adequately sensitive to detect changes associated with the syndrome.^{2,6,28} Nerve studies can be useful in localizing the level of nerve compression while also identifying other concomitant disease processes.^{6,28,41} These studies should be considered for all patients because comparative studies can assist in postoperative decision making should the signs and symptoms not improve. If there is concern about a neck, chest, or elbow osseous abnormality, plain radiographs can be helpful.

Conservative treatment (ie, activity modification, padding, splinting) is recommended for those patients with mild symptoms^{6,36,42–44}; no benefit has been seen after local steroid

injection into the cubital tunnel.^{45,46} The goals at this stage of treatment are to decrease both the severity and frequency of symptoms as well as to prevent disease progression. A list of indications and contraindications has been included in Box 1. Patients meeting surgical indications and failing nonoperative management are then considered for surgery.

Box 1

Indications and contraindications

Indications

- Ulnar neuropathy at the elbow (mild, moderate, severe)

Contraindications

- Elbow trauma
- Morbid obesity
- Ulnar nerve subluxation at the elbow (preoperatively or intraoperatively)
- Recurrent or persistent postoperative ulnar neuropathy at the elbow

Preparation and Patient Positioning

Anesthesia—Several options exist for anesthesia: general, regional (axillary block), or local infiltration of the operative field (5–10 mL of 1% plain lidocaine or 0.5% bupivacaine into planned incision) with or without sedation.

Position—Patients are in the supine position with the operative arm on an extremity table. The arm is abducted, and the elbow is flexed to 90° and propped on surgical towels.

Surgical approach

- Step 1: The incision is designed as a 1.5- to 3.0-cm longitudinal or transverse skin incision marked at the midpoint between the medial epicondyle and the olecranon (Fig. 1).

Some investigators avoid placing the incision directly over the cubital tunnel to prevent a continuous scar extending from the skin to the ulnar nerve.

- Step 2: If a tourniquet is used, the extremity is exsanguinated and the tourniquet is inflated to 250 mm Hg.
- Step 3: The skin incision is made, and the subcutaneous tissue is divided. Extreme care is taken to avoid crossing branches of the medial antebrachial cutaneous nerve (Fig. 2). The skin and soft tissues are retracted using Senn retractors.
- Step 4: The fascial layer overlying the nerve is exposed, and the ligament of Osborne is divided using scissors (Figs. 3 and 4). Only the superficial surface of the nerve is exposed and no neurolysis is performed, decreasing the likelihood for nerve subluxation. Decompression is carried proximally to the arcade of Struthers and intermuscular septum and distally between the 2 heads of the FCU. Inspection for proximal or distal sites of compression is performed and addressed as necessary. If subluxation is present after in situ release, then transposition is indicated.

Although Hahn and colleagues⁴⁷ noted the equivalent outcomes after minimally invasive medial epicondylectomy with in situ release as compared with anterior subcutaneous transposition, the role of this technical modification is not discussed in this article.

- Step 5: The tourniquet is deflated, and meticulous hemostasis is ensured. The skin is closed in layers with either an interrupted or subcuticular suture in the skin, and a light circumferential dressing is applied without a splint (Fig. 5).

Complications

The medial antebrachial cutaneous nerve is at risk with procedures about the medial elbow. The nerve is known to have branches coursing in an anterior to posterior direction, crossing from 6 cm proximal to 6 cm distal to the medial epicondyle.^{48,49} This injury is very poorly tolerated, possibly leading to neuroma, hypesthesia, hyperesthesia, painful scarring,^{8,10,49–56} and a possible delay in return to work.¹⁰

Inadequate release of regional structures is a potential complication of ulnar nerve decompression. No evidence exists regarding the frequency of this complication in patients undergoing minimal-incision in situ release. The most common site of persistent ulnar nerve compression is the origin of the FCU.⁵⁶ The intermuscular septum is implicated as a secondary site of compression almost exclusively in those undergoing transposition techniques. The theoretical risks of ulnar nerve compression or kinking at the septum should be minimal with an in situ release.

Iatrogenic injury to the ulnar nerve is also a possible risk, particularly to the motor branches coursing into the FCU.⁵⁶ Ulnar nerve instability/subluxation^{56–58} and elbow joint instability should be minimal because dissection with an in situ approach is limited. Postoperative scarring leading to perineural fibrosis can cause surgical failure.^{58–60}

Postoperative Care

There are no significant postoperative activity restrictions, and the dressing is removed in 2 to 3 days. Scar massage techniques are offered at 3 weeks postoperatively.

OUTCOMES

The fundamental point of contention with regard to surgical management is whether the nerve suffers from compression, traction, or a combination of both² and whether both of these factors are clinically significant. The landmark study by Gelberman and colleagues¹⁶ concluded that in situ release failed to change the ulnar nerve intraneural pressure at or 4 cm proximal to the cubital tunnel. This finding resulted in increased disfavor for the in situ approach, particularly among orthopedic surgeons.² In contrast, other studies have shown in situ release to be both safe and effective for the relief of ulnar nerve compression symptoms, despite laboratory data showing that the nerve suffers from significant traction with increasing elbow flexion.²²

Evidence for In Situ Release

Evidence supporting the role of in situ release is abundant (Table 1). In addition to the outcomes noted in Table 1, excellent to good pain relief has also been demonstrated in 75% to 90% of patients following in situ decompression.⁸ The favorable outcomes found in these representative studies, combined with the lower risk for both wound infection and surgical-site tenderness,^{22,23,63,65} have generated increased interest for in situ techniques. In situ release also theoretically maintains the intrinsic and extrinsic vascularity of the ulnar nerve.⁶⁶ In the setting of an improved complication profile with equivalent outcomes, the less invasive, technically simpler option should be selected.

Evidence for Minimal-Incision In Situ Release

Minimally invasive procedures are becoming increasingly popular.⁶⁷ This phenomenon is overwhelmingly patient driven; however, benefits of these techniques are apparent. Minimal skin incision cubital tunnel release frequently offers adequate exposure while shortening recuperation time⁶⁷ and increasing patient satisfaction.⁶⁸ Furthermore, larger incisions (6–10 cm) put the variably located branches of the medial antebrachial cutaneous nerve at risk.

The amount of comparative evidence for the use of minimal-incision cubital tunnel release techniques is growing, and all existing studies show a benefit (Table 2). These studies, however, are limited by the lack of control groups, a generally small sample size, and nonstandardized outcomes measures. To address these limitations, the Surgery of the Ulnar Nerve Study Group was formed. The primary objective of this group was to examine outcomes after simple in situ ulnar nerve decompression using a 3-cm incision. The data derived from this collaboration of 5 medical centers were also used to assess for the most responsive pre-surgical and postsurgical disability instruments. The greatest clinical improvement after in situ decompression was found to occur in the first 6 weeks postoperatively, reaching a plateau by 3 months postoperatively.⁷³ A review of disability instruments showed that the Michigan Hand Questionnaire (MHQ) and Carpal Tunnel Questionnaire (CTQ) were better able to detect clinically significant postsurgical improvements than the Disabilities of the Arm, Shoulder, and Hand (DASH) Questionnaire.⁷⁴ Lastly, despite a small change in MHQ, DASH, and CTQ scores, simple decompression for cubital tunnel syndrome was able to provide objective measures of patient satisfaction.⁷⁵

SUMMARY

With initiatives to decrease operative morbidity, complications, and associated costs, minimal-incision techniques have found an expanding role within multiple specialties. Minimal-incision in situ open techniques for ulnar nerve release at the elbow provide adequate exposure and reproducible, satisfactory outcomes. Furthermore, there is no need for endoscopic equipment and the resultant dependence on staff adequately trained to operate and troubleshoot equipment. More robust research with a focus on complications and standard outcome measures will be required to further define the role of minimal-incision techniques. This technical modification, however, augments the increasing armamentarium of the hand surgeon.

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KEY POINTS

- Clinical evaluation is paramount in the diagnosis of cubital tunnel syndrome because electrodiagnostic testing often is not sufficiently sensitive to detect changes associated with the syndrome.
- A 1.5- to 3.0-cm longitudinal or transverse skin incision is created at the midpoint between the medial epicondyle and the olecranon, exposing the ulnar nerve; no neurolysis is performed.
- Increasing evidence shows minimally invasive open in situ release to be both safe and effective for the relief of ulnar nerve compression symptoms.

Fig. 1.
Preoperative markings for minimal-incision ulnar nerve decompression.

Fig. 2.
Care must be taken not to damage the crossing branches of the medial antebrachial cutaneous nerve.

Fig. 3.
Ligament of Osborne overlying the ulnar nerve.

Fig. 4.
The ulnar nerve is exposed following incision of the overlying ligament of Osborne and fascial layers.

Fig. 5.
Postoperative appearance after ulnar nerve decompression.

Table 1

Summary of articles comparing in situ release with transposition techniques

	Study Design	Study Population	Outcomes	Complications
Bartels et al, ²² 2005	Prospective comparison of in situ release vs subcutaneous anterior transposition	152 patients followed for 1 y (75 in situ releases, 77 transpositions)	Equivalent	Higher in transposition group
Nabhan et al, ⁶¹ 2005	Randomized study of simple decompression vs subcutaneous anterior transposition	66 patients (32 in situ releases, 34 transpositions)	Equivalent	—
Foster & Edshage, ⁶² 1981	Retrospective review of simple decompression vs subcutaneous anterior transposition	48 cases	Equivalent pain relief improved paresthesia relief and return of intrinsic function with transposition	—
Biggs & Curtis, ⁶³ 2006	Prospective randomized study of in situ release vs submuscular transposition	44 patients (23 in situ releases, 21 transpositions)	Similar rates of improvement (61% in situ vs 67% transposition)	Higher risk for wound complications in transposition group
Caliandro et al, ⁶⁴ 2011	Cochrane Review comparing simple decompression vs submuscular or subcutaneous transposition	—	Equivalent, even in setting of severe preoperative nerve impairment	Higher risk for infection in transposition group

Table 2

Summary of articles reporting minimal-incision in situ release outcomes

	Study Design	Study Population	Outcomes	Complications
Taniguchi et al, ⁶⁹ 2002	Prospective study of 1.5- to 2.5-cm incision in situ release	17 patients (18 elbows)	Improved Messina scores, no nerve subluxation	1 hematoma
Cho et al, ⁷⁰ 2007	Prospective study of <2.0-cm incision in situ release vs traditional in situ release	15 patients (5 treated with minimal incision)	Excellent to good outcomes (Modified Bishop scores)	None, no recurrences or subluxation
Calisanellet et al, ⁷¹ 2011	Prospective study of in situ release with two 2-cm incisions (proximal and distal to cubital tunnel)	4 patients	Excellent results (3 of 4 patients), good results (1 of 4) (Wilson and Krout grading system)	None
Jeon et al, ⁷² 2010	Prospective study of minimal skin incision	66 patients	Satisfactory results in 81% (Messina scores) in patients with McGowan stage I/II disease	2 cases of hematoma