ULNAR NERVE ENTRAPMENT NEUROPATHY AT THE ELBOW: SIMPLE DECOMPRESSION

Jason H. Huang, M.D.
Department of Neurosurgery, University of Pennsylvania, Philadelphia, Pennsylvania

Uzma Samadani, M.D., Ph.D.
Department of Neurosurgery, University of Pennsylvania, Philadelphia, Pennsylvania

Eric L. Zager, M.D.
Department of Neurosurgery, University of Pennsylvania, Philadelphia, Pennsylvania

Reprint requests:
Eric L. Zager, M.D., Department of Neurosurgery, Hospital of the University of Pennsylvania, 3400 Spruce Street, Philadelphia, PA 19104.
Email: zagere@uphs.upenn.edu

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ONLINE DIGITAL VIDEO

ULNAR NERVE ENTRAPMENT neuropathy at the elbow, or the cubital tunnel syndrome, is frequently encountered in neurosurgical practice as the second most common peripheral nerve entrapment after carpal tunnel syndrome. Patients typically present with weakness or atrophy of the hand as well as paresthesias in the ulnar nerve distribution. The diagnosis can be confirmed with a careful clinical examination and electrophysiological studies. Patients who have failed conservative therapy are considered for surgery. Although a number of surgical options are available, simple decompression of the ulnar nerve can achieve satisfactory results with appropriate patient selection. We describe the relevant anatomy and surgical techniques for simple in situ decompression of the ulnar nerve at the elbow.

KEY WORDS: Cubital tunnel syndrome, Entrapment neuropathy, Peripheral nerve, Ulnar nerve decompression

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The portion of the arm that laypeople refer to as the "funny bone" is the superficial site at which the ulnar nerve traverses the elbow and exposes its vulnerability not only to jostling against an unanticipated external menace but also to compression from within the arm itself. Neuropathy at this site, also known as the cubital tunnel syndrome, is the second most frequent entrapment neuropathy in adults (2–4). It has been postulated to be three times more common in men than women because the latter have a smaller coronoid body and more substantial subcutaneous fat (5, 15), but its pathophysiology is not entirely clear. Historical association of delayed cubital tunnel syndrome with trauma or arthritis in the elbow (so-called tardy ulnar palsy) has led to a subsequent recognition that the majority of cases are idiopathic.

Ulnar nerve entrapment neuropathy at the elbow typically has an insidious onset, resulting in paresthesias in the ring and small fingers of the hand, elbow pain, and hand weakness. Frequently, symptoms are worsened by activity that involves repeated or sustained elbow flexion. Unlike with the carpal tunnel syndrome, pain is usually not a predominant feature early in the course of the syndrome. Early symptoms may be purely motor and manifest as hand clumsiness, weakness, and cramping of the small muscles of the hand. On examination, elbow flexion with full wrist extension for up to 3 minutes that reproduces pain, numbness, or tingling symptoms is considered a positive sign, analogous to Phalen's test for carpal tunnel syndrome (1). Froment's sign confirms a weak adductor pollicis muscle (17). A Tinel's sign may be present over the course of the ulnar nerve in the postcondylar groove. In advanced cases, ulnar clawing of the hand caused by weakness of the third and fourth lumbricals can occur, with hyperextension at the metacarpophalangeal joints and flexion of the interphalangeal joints. Sensory examination may detect loss of two-point discrimination or light touch in the ulnar nerve distribution. A classification system for symptom severity caused by posttraumatic ulnar neuropathy was proposed by McGowan in 1950 (13).

The clinical diagnosis of ulnar nerve entrapment neuropathy at the elbow can be confirmed by electrophysiological studies: nerve conduction velocities of the ulnar nerve across the elbow are usually decreased relative to velocity in the forearm segment (4). Motor studies are more sensitive than mixed sensory studies at localizing ulnar neuropathy to the elbow (18).

Conservative treatment is appropriate for patients with minor symptoms and no neurological deficit. Patients with external compression neuropathy occurring as a consequence of general endotracheal anesthesia or prolonged bedrest are generally not treated surgically because

of poor outcomes in this group (14). Conservative treatment measures include avoiding any activities that could exacerbate the compression (repetitive extreme flexion of the elbow, resting the elbow on hard surfaces, etc.), protective elbow sleeves, splinting the elbow to maintain 45 degrees of flexion or positioning a pillow to prevent extreme elbow flexion at night, and corticosteroid injections. Patients whose symptoms have progressed despite conservative therapy and those who present with weakness, atrophy, or significant denervation on the electromyogram should be considered for surgical treatment.

SURGICAL ANATOMY

The ulnar nerve, which contains fibers from C8 and T1 (and infrequently from C7), is the largest terminal branch of the medial cord of the brachial plexus. The nerve enters the arm with the axillary artery and courses medially or occasionally posteriorly to the brachial artery before piercing the intermuscular septum approaching the elbow. The ulnar nerve then travels along the border of the medial head of the triceps and enters the postcondylar groove lateral to the medial epicondyle. At the elbow, the ulnar nerve enters the forearm between the medial epicondyle and olecranon through the cubital tunnel. The roof of the cubital tunnel is a fibrous aponeurosis that thickens to form the cubital tunnel retinaculum or arcuate ligament of Osborne, a potential site of compression for the ulnar nerve (9) (*Fig. 1*). This retinaculum connects the tendinous origin of the humeral and ulnar heads of the flexor carpi ulnaris. This fibrous band is approximately 4 mm wide and extends from the medial epicondyle to the tip of the olecranon. Its fibers are oriented transversely and are taut in elbow flexion. The medial collateral ligaments and the joint capsule form the floor of the cubital tunnel, and the medial epicondyle and olecranon form the walls. Within the tunnel, the ulnar nerve gives off branches to the elbow joint. Exiting the tunnel, the ulnar nerve then passes into the forearm between the humeral and ulnar heads of the flexor carpi ulnaris muscles, another potential site of compression. Approximately 3 cm distal to the cubital tunnel, the ulnar nerve pierces the flexor pronator aponeurosis, an additional potential site of compression (8). Intraoperative electrical studies have demonstrated that the most common site of ulnar nerve compression occurs within the postcondylar groove (10). Distally, the nerve innervates the flexor digitorum muscles before entering Guyon's canal at the wrist. The terminal branches of the ulnar nerve supply motor innervation to the adductor pollicis, the flexor pollicis brevis, the hypothenar muscles, the third and fourth lumbricalis, and all of the interosseous muscles. The sensory distribution of the nerve includes the palmar and dorsal medial aspects of the hand, often including half of the ring finger.

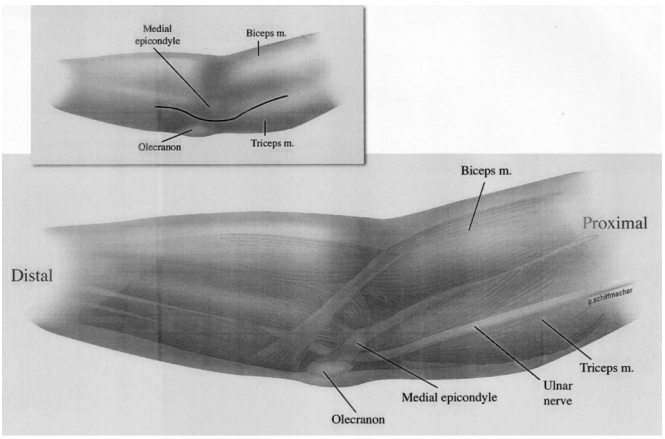

FIGURE 1. *Artist's illustration of the surface anatomy for a right ulnar decompression (right elbow, medial surface).* Solid line in inset *indicates our preferred incision over the course of the nerve.*

Because the ulnar nerve crosses the extensor aspect of the elbow in a superficial site with little supporting epineurium, it is prone to injury after trauma. The motor fibers that supply the intrinsics of the hand have a superficial location, and those that supply the flexor carpi ulnaris and ulnar half of the flexor digitorum profundus are deeper. Thus, intrinsic weakness of the hand muscles is a common presentation for patients with cubital tunnel syndrome. The sensory fibers are also located superficially as the ulnar nerve traverses the extensor elbow, explaining why paresthesias are another common early feature of the cubital tunnel syndrome.

SURGICAL OPTIONS

Surgical management of the ulnar nerve entrapment at the elbow is determined by the patient's preoperative symptoms and intraoperative findings. Commonly performed procedures include simple or in situ decompression by unroofing the cubital tunnel, anterior subcutaneous transposition, intramuscular transposition, submuscular transposition, and medial epicondylectomy (2, 3, 17). Simple decompression of the ulnar nerve, which is the subject of this article, is performed by neurosurgeons more commonly than the other surgical options for the treatment of cubital tunnel syndrome (12) and is satisfactory for most cases (3). If patients are found to have nerve subluxation at the time of surgery, anterior transposition may be indicated (17). Advanced age, prolonged duration of symptoms, and weakness of intrinsic hand musculature are associated with poorer outcomes (7). With careful patient selection, the success rate for simple decompression ranges from 80 to 92% (3, 6, 10, 11). Advantages of this procedure are its relative simplicity; preservation of vascular supply to the nerve, which remains in its anatomic location; and short postoperative recovery time, enabling early physical therapy and rehabilitation.

OPERATIVE TECHNIQUE
(*see video at web site*)

Ulnar nerve decompression can be performed under monitored anesthesia care with the patient receiving intravenous sedation and local anesthesia. Alternatively, some surgeons perform the procedure using an axillary block or general

anesthesia, according to patient preference. The patient is positioned supine, with the arm extended and abducted to 90 degrees at the shoulder and the forearm supinated. The entire arm is prepared and draped in the usual sterile manner. In our practice, we do not use paralytic anesthetic agents or a tourniquet. The local anesthetic must be infiltrated very superficially to avoid injury to the nerve. In thin patients, the nerve is easily palpated adjacent to the medial humeral epicondyle.

The decompression is performed through a 6- to 8-cm curvilinear incision overlying the course of the ulnar nerve as it traverses the elbow lateral to the medical epicondyle (*Fig. 2*). When making the skin incision, it is important to be aware of the posterior branches of the medial brachial and medial antebrachial cutaneous nerves, because injury to these branches may increase surgical morbidity (16).

After the skin has been infiltrated with local anesthetic, the skin and underlying subcutaneous tissues are incised with a No. 15 blade scalpel. The deep fascia overlying the nerve is divided with either a Metzenbaum scissors or No. 15 scalpel blade. Just underneath the fascia, the ulnar nerve is identified proximal to the postcondylar groove and anterior to the medial head of the triceps. The nerve is then followed distally into the postcondylar groove. The fascial roof between the medial epicondyle and olecranon is sharply divided in a proximal-to-distal direction. The groove is the site of maximal nerve compression in most cases. For this procedure, we expose the nerve only along its course. Distal to the postcondylar groove, the ulnar nerve is followed as it courses deep to the aponeurosis between the two heads of the flexor carpi ulnaris muscle, under the so-called Osborne's band. By elevating the distal skin edge, this aponeurosis may be incised to release any distal compression. We do not perform internal neurolysis during primary procedures; it has not proved beneficial and in fact may be harmful. Furthermore, the nerve is not dissected circumferentially or mobilized out of its bed. This technique minimizes trauma to the nerve and preserves its nutrient blood supply.

Once the exposed course of the ulnar nerve has been inspected to establish that no residual compression is present, the nerve is examined for subluxation by moving the elbow through its range of motion. If there is significant subluxation, most surgeons would argue that a transposition procedure is warranted. Meticulous hemostasis is achieved by use of bipolar cautery, and the wound is irrigated thoroughly with sterile saline solution. The wound is closed in anatomic layers: the subcutaneous tissues are reapproximated with 3-0 interrupted, inverted Vicryl sutures (Ethicon, Inc., Somerville, NJ). The skin is closed with either simple running 4-0 nylon sutures or subcuticular absorbable 4-0 sutures, and a soft compressive dressing is applied. We provide our patients with a sling for comfort in the immediate postoperative period and encourage early range of motion for the arm and hand.

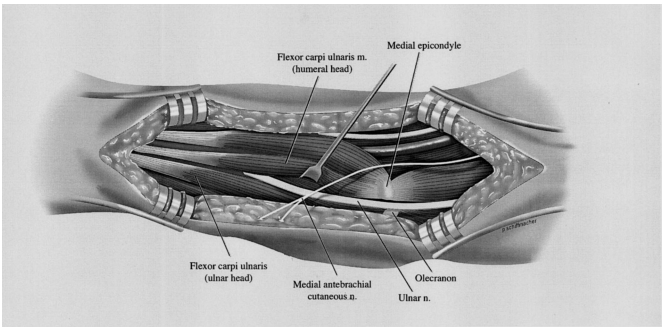

FIGURE 2. *Artist's illustration of the surgical anatomy of the ulnar nerve in the elbow (right elbow, medial view).*

OUTCOMES

Surgical outcomes are a function of the patient's age and the duration and intensity of symptoms. Resolution of paresthesias occurs more rapidly than return of muscular strength. The pathogenesis of the neuropathy also affects outcome. Patients with external compression neuropathy, posttraumatic cubital tunnel syndrome, and coexisting mixed polyneuropathies from diabetes or alcoholism, for example, may also have more gradual and less pronounced improvement of symptoms. Overall, 80 to 90% of patients can achieve a satisfactory outcome after simple decompression surgery of the ulnar nerve (3, 10).

CONCLUSION

Simple decompression of the ulnar nerve at the elbow is a straightforward procedure for relief of paresthesias and motor symptoms caused by entrapment neuropathy of the ulnar nerve at the elbow. It is the most commonly performed procedure for the treatment of this entrapment syndrome by neurosurgeons. It has the advantages of least morbidity, shortest recovery, and maintenance of the nerve in its anatomic location, keeping its vascular supply intact.

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COMMENTS

This article describes the procedure of simple decompression of the ulnar nerve at the level of the elbow for patients with ulnar entrapment syndrome. No outcomes or results are provided, but the technique is well documented and the drawings are of value. It should be emphasized that a neurolysis, even an external neurolysis of the nerve, is not performed, but rather, the nerve is only exposed and not manipulated or moved at all. External neurolysis would include a circumferential freeing up of the nerve 360 degrees around over a length of nerve. If that is done and the nerve is not transposed and secured in some way, the nerve would most likely translocate on flexion of the elbow whether or not it did that before surgery.

Such a simple procedure may have merit for the milder cases of entrapment but in my view should be reserved for only such cases. More severe entrapment neuropathy warrants transposition, although subcutaneous placement frequently works when the nerve is carefully resecured without angulation. I prefer submuscular placement, in which the course of the nerve is less likely to be angulated and the nerve at the level of the elbow is covered by muscle.

The following conclusions are based on our own operative electrophysiological studies on 364 patients who had not had previous operations, having submuscular placement, and followed up for a minimum of 1.5 years (1). Ulnar entrapment neuropathies may demonstrate defects in the nerve action potentials intraoperatively, even when preoperative electromyograms and conduction velocity studies indicate that the responses are within normal limits. Notably, intraoperative inching studies of the nerve not only show a conductive defect but also show that these changes begin just proximal to the elbow and are at a maximal level in the region of the olecranon notch, not distally under the flexor carpi ulnaris. These electrical changes are usually correlated with thickening, thinning, or, in some cases, swelling of the nerve in the notch region. This suggests that, when there is significant and symptomatic ulnar entrapment, the problem is usually in the area of the olecranon notch, and therefore, our preferred surgical method for elbow-level entrapment is not only neurolysis but also transfer of the nerve out of the notch and to a submuscular level.

Outcomes showed that function improved by one Louisiana State University Health Science Center grade in 58% of patients, in 26% by two grades, and in 9% by three grades. Twenty-two patients had no improvement in function, and two patients had a one-grade decrease in function (1).

David G. Kline
New Orleans, Louisiana

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The authors describe the treatment for ulnar nerve entrapment, neuropathy at the elbow also known as cubital tunnel syndrome. This very common. Peripheral neuropathy has a well-described constellation of symptoms and signs as well as diagnosis and treatment. The authors have comprehensively delineated the evaluation and conservative treatment and the decision making to advance toward surgical intervention. The basis for the simple decompression of the ulnar nerve is highlighted and remains the most common procedure for this level of entrapment. We have found that this simple decompression has achieved satisfactory outcomes in the vast majority of patients without the need for a circumferential mobilization causing transposition of the nerve and potentially traumatizing the nerve and its nutrient blood supply. The important point is that the majority of patients will benefit from the simple decompression described. It is important to take each patient individually, defining the different abnormality that is intrinsic to each, and decide on the optional surgical technique/approach on the basis of the preoperative evaluation and the intraoperative findings. Finally, if neurosurgeons are to maintain a presence in the treatment of peripheral entrapment neuropathies and injury, it is important to be involved in the evaluation and surgical treatment of these patients. Neurosurgeons are at the cutting edge of further understanding of the mechanisms and the use of advanced technologies to improve the surgical techniques and outcomes. Our goal should be decreased invasiveness with improved response to treatment.

P. David Adelson
Pittsburgh, Pennsylvania