Intraoperative Measurement of Pressure Adjacent to the Ulnar Nerve in Patients With Cubital Tunnel Syndrome

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Purpose: Little is known about whether the pressure adjacent to the ulnar nerve actually is increased in patients with cubital tunnel syndrome or if it is a causative factor. We measured the pressure adjacent to the ulnar nerve in patients with cubital tunnel syndrome during surgery and verified whether or not there was an association with patient age, duration of the disease, motor nerve conduction velocity, and severity of the ulnar nerve neuropathy.

Methods: Eight elbows in 8 patients with an average age of 62 years were treated surgically and the extraneural pressures within the cubital tunnel were measured during surgery by using a fiberoptic microtransducer. Pressure was measured 3 times with the elbow fully extended and then 3 times with the elbow flexed 130°. The transducers were placed at 1, 2, and 3 cm distal to the proximal edge of the Osborne ligament. The severity of the neuropathy was evaluated according to Akahori's classification. The ulnar nerve palsy was graded as stage III in 5 patients and as stage IV in 3 patients.

Results: The average pressures within the cubital tunnel at 1, 2, and 3 cm distal to the proximal edge of the cubital tunnel retinaculum with the elbow flexed were 105, 29, and 18 mm Hg, respectively. The pressures at 1 and 2 cm distal to the proximal edge of the cubital tunnel retinaculum were significantly higher in elbow flexion than in elbow extension. There was also a positive correlation between the pressure and patient age but this was not significant The pressures correlated significantly with the stage of ulnar nerve neuropathy, motor nerve conduction velocity, and disease duration

Conclusions: The extraneural pressure within the cubital tunnel actually was increased in the patients and compression of the ulnar nerve might be a causative factor of cubital tunnel syndrome. (J Hand Surg 2006;31A:553–558. Copyright © 2006 by the American Society for Surgery of the Hand.)

Key words: Ulnar nerve, cubital tunnel, Osborne ligament, pressure, neuropathy.

Cubital tunnel syndrome is accepted commonly as the second most frequent entrapment neuropathy in the upper extremity; however, its etiologies have not been determined conclusively. There still is controversy as to whether compression by the wall of the cubital tunnel, stretching of the ulnar nerve, or both of these factors can occur progressively to contribute to the neuropathy.

Previous studies have indicated that a decrease in the volume of the cubital tunnel secondary to an increase in the angle of the elbow flexion may result in compression of the ulnar nerve.[1,2] Several investigators[3–8] have studied interstitial pressure within the cubital tunnel and shown increases in both extraneural and intraneural pressures of the ulnar nerve in association with increasing elbow flexion. Most of these studies were performed using cadaveric models. Because their specimens had none of the pathologic characteristics associated with entrapment of the ulnar nerve at the elbow, the results for these normal elbows may not apply directly to patients who have cubital tunnel syndrome. It is not known whether the pressure within the cubital tunnelin-

Table 1. Stages of Function of the Ulnar Nerve According to the Akahori[9] Classification

	Condution Velocity		Clinical Symptoms			
				Motor		
Stage	Motor Nerve	Sensory Nerve	Sensory	Muscle Atrophy	Muscle Weakness	Clawing
I	Normal	Normal	Normal or mild paresthesia	(+ or −)	(+ or −)	−
II	Normal	Slowed	Hypoesthesia +	+	(+ or −)	(+ or −)
III	Normal or slowed	Slowed or not measurable	Hypoesthesia +	+	+	(+ or −)
IV	Slowed	Not measurable	Hypoesthesia ++	++	++	++
V	Slowed or not measurable	Not measurable	Hypoesthesia ++ or analgesia	++	++	++

−, Absent; +, present; ++, severe.

creases in patients with cubital tunnel syndrome or if it is a causative factor.

In the present study we measured the pressure adjacent to the ulnar nerve in patients with cubital tunnel syndrome during surgery and ascertained whether there was an association with patient age, duration of disease, motor nerve conduction velocity, and disease stage.

Materials and Methods

Patients

Eight elbows of 8 patients with cubital tunnel syndrome who had subcutaneous anterior transposition of the ulnar nerve were included in this study (Table 1). Informed consent was obtained from each patient before enrollment in the study and the study was approved by the institutional review board of Sapporo Medical University. There were 7 men and 1 woman with an average age of 60 years (range, 39–81 y). Preoperative radiographs showed osteoarthritis in 8 of 8 elbows. Each patient complained of severe symptoms including pain, numbness, and paresthesia of the ulnar hand and diminished strength. The symptoms were reproduced by flexing the elbow. The ulnar nerve at each elbow had a positive Tinel's sign. Motor nerve conduction velocity of the ulnar nerve in the elbow segment was decreased in all 8 elbows, which were measured with the elbow at 30° of flexion. Intrinsic atrophy was noted in 8 of 8 patients. According to the classification system by Akahori[9] 5 patients were graded as stage III and 3 patients as stage IV. The Akahori[9] classification system evaluates the severity of cubital tunnel syndrome with nerve conduction velocity and clinical symptoms (Table 2). The 8 patients selected for this study represented those with severe symptoms of cubital tunnel syndrome.

Surgical Technique and Measurement of Extraneural Pressure

Under tourniquet control the dissection was carried down through the subcutaneous tissue. The ulnar nerve was found in the proximal incision and tagged with a small Penrose drain. The fascia overlying the ulnar nerve was incised in a proximal-to-distal direction until the entrance of the cubital tunnel. The entrance of the cubital tunnel is the proximal edge of the Osborne ligament. We defined the Osborne ligament as consisting of cubital tunnel retinaculum and the aponeurosis of the flexor carpi ulnaris muscle (Fig. 1). As shown by O'Driscoll et al[10] the cubital tunnel retinaculum is an approximately 4-mm–proximal-distal length fibrous band extending from the medial epicondyle to the olecranon and perpendicular to the flexor carpi ulnaris muscle. It is located just proximal to the aponeurosis of the flexor carpi ulnaris muscle. With the elbow flexed its proximal edge can be palpated distinctly from the deep fascia, with which it is continuous. Distally the deep forearm fascia invests the flexor carpi ulnaris in 2 layers, with the deeper layer continuing distally for about 3 cm, at which point the cubital tunnel ends.[10] The extraneural pressures in the cubital tunnel were measured by using a fiberoptic microtransducer (Camino intraparenchymal fiberoptic device; Camino Laboratories, San Diego, CA) and were recorded on a strip-chart recorder.[11] The 1.32-mm–diameter fiberoptic microtransducer was inserted gently into the cubital tunnel between the roof and the ulnar nerve in a distal direction (Fig. 1). Pressures in each elbow were recorded at 3 locations: 1, 2, and 3 cm distal to the proximal edge of the cubital tunnel retinaculum. Measurements were performed at each location with the elbow at 0° and 130° of flexion. The shoulder was