Intramuscular compared with subcutaneous transposition for surgery in cubital tunnel syndrome

MR Emamhadi¹, AR Emamhadi², S Andalib³

¹Brachial Plexus and Peripheral Nerve Injury Center, Guilan University of Medical Sciences, Rasht, Iran

²School of Medicine, Guilan University of Medical Sciences, Rasht, Iran

³Neuroscience Research Center, Department of Neurosurgery, Poursina Hospital, School of Medicine, Guilan University of Medical Sciences, Rasht, Iran

ABSTRACT

BACKGROUND There is no consensus on the most effective surgical technique in the treatment of cubital tunnel syndrome. Anterior subcutaneous transposition (AST) and anterior intramuscular transposition (AIT) are common surgical treatments in this regard. The aim of this study was to compare the clinical outcomes of these two surgeries for cubital tunnel syndrome.

METHODS In a retrospective study, we compared surgical outcomes (pain, sensation, motor recovery, atrophy, and total satisfaction) in 40 patients undergoing AIT and 43 undergoing AST of the ulnar nerve.

RESULTS The patients undergoing AIT showed a significant improvement in all the outcomes after the surgery ($P = 0$); however, those undergoing AST only experienced an improvement in pain and sensation after the surgery ($P = 0$). Comparing the two surgeries, we found that there was a high total satisfaction with AIT compared with AST ($P = 0$). When we independently compared each outcome in the two groups, we found that the muscle force recovery was significantly improved in the AIT group compared with the AST group ($P = 0$).

CONCLUSIONS AIT is preferable to AST for the surgical treatment of cubital tunnel syndrome. In particular, AIT achieves a better motor recovery of the ulnar nerve compared with AST.

KEYWORDS

Cubital tunnel syndrome – Anterior subcutaneous transposition – Anterior intramuscular transposition – Clinical outcomes

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CORRESPONDENCE TO

Sasan Andalib, E: andalib@gums.ac.ir

Introduction

The hand is the most often harmed portion of human body.¹ The elbow is the most frequent site of ulnar nerve compression, giving rise to cubital tunnel syndrome. Cubital tunnel syndrome is the second most common entrapment neuropathy after carpal tunnel syndrome.² The ulnar nerve mainly provides motor innervation for the intrinsic muscles of the hand. The neuropathy of cubital tunnel syndrome stems from changes in the volume and the pressure of the cubital tunnel due to flexion and extension exerted on the ulnar nerve. Elbow flexion results in traction and excursion of the ulnar nerve and increases intraneural pressure.^{3,4} Prolonged elbow flexion gives rise to neuropathy and demyelination, commonly situated in the bulbous swelling proximal to the nerve entry into the cubital tunnel.⁵

At the elbow, there are five anatomical regions wherein ulnar nerve may be compressed: the arcade of Struthers, the

proximal epitrochlear region, the epitrochlear–olecranon channel, the fibrous arch between the humeral and ulnar portions of the flexor carpi ulnaris, known as Osborne's arcade, and the vertical fibrous septum that stems from the ulna and separates the ulnar nerve and the ulnar part of the flexor carpi ulnaris from the flexor pronator muscles supplied by the median nerve.

Numbness and tingling of the ulnar aspect of the hand, weakness and clumsiness, hypothenar and first dorsal interossei atrophy are the most common manifestations of cubital tunnel syndrome. Dellon⁶ described a grading system according to the severity of symptoms: mild (intermittent paraesthesia and subjective weakness), moderate (intermittent paraesthesia and measurable weakness in pinch and/or grip) or severe (permanent paraesthesia and palsy).⁶ McGowan's staging system has no sensory part and classifies ulnar nerve compression into grade I (minimal with no detectable

motor weakness), grade II (intermediate) or grade III (severe with paresis or paralysis of the intrinsic muscles).⁶

If conservative therapy of ulnar nerve entrapment fails, surgery at the elbow is recommended. The current surgical techniques for the treatment of cubital tunnel syndrome include simple decompression, medial epicondylectomy and anterior transposition of the ulnar nerve. The latter is carried out in three different ways: subcutaneous, intramuscular (within the flexor pronator muscle mass) and submuscular (beneath the flexor pronator muscle mass) anterior transpositions.⁷ Nabhan et al.⁸ reported no significant differences in outcome between simple decompression and anterior subcutaneous transposition (AST) and recommended simple decompression of the ulnar nerve in patients without deformity of the elbow as a minimally invasive technique. Thus, no one surgical technique is superior to another.⁹ This lack of definition may be a result of inconsistency in the literature in reporting preoperative severity of ulnar nerve compression or postoperative outcomes. Numerous studies have focused on ulnar nerve compression at the elbow but no study has compared AST with anterior intramuscular transposition (AIT). The present study compares surgical outcomes of AST and AIT for cubital tunnel syndrome.

Patients and Methods

In this retrospective study, an initial review was carried out of consecutive patients with cubital tunnel syndrome (confirmed by clinical and electrophysiological findings) who were referred to the Brachial Plexus and Peripheral Nerve Injury Center, Guilan University of Medical Sciences, Rasht, Iran, from October 2008 to October 2012. Patients undergoing AST and AIT surgeries for treatment of cubital tunnel syndrome were included. The exclusion criteria were deformation or distortion of cubital tunnel by previous trauma of elbow, recurrent cubital tunnel syndrome, previous surgery or considerable problems in the neck and shoulder confirmed by magnetic resonance imaging on the side of the surgery. Ultimately, 43 patients with AIT and 40 patients with AST were reviewed.

We had a rare case of a ganglion cyst at the elbow causing cubital tunnel syndrome (Fig 1). We collected data regarding surgical outcomes, including pain, sensation, motor recovery and atrophy. Table 1 shows the scoring system of the

Figure 1 Ganglion cyst at the elbow causing cubital tunnel syndrome.

outcomes. Pain was assessed according to the visual analogue scale and graded as: 0, severe (8–10); 1, slight pain (4–7); 2, no pain (0–3). Semmes-Weinstein filaments for sensory distribution were evaluated using the Yale sensory scale and classified as 0, no sensation (0); 1, decreased or abnormal sensation (1); 2, normal sensation (2). Muscle force was evaluated using Medical Research Council scoring and classified as 0, poor (0–1); 1, moderate (2–3); 2, good (4–5). Muscle atrophy was rated as 0, severe; 1, moderate; 2, none. All scores were added and the total scores (total satisfaction) were rated as 0–2, poor; 3–4, moderate; 5–6, satisfactory; 7–8, good. All outcomes were reexamined 12 months after surgery. The initial and reexamination outcomes were compared for each surgery. More importantly, the two nerve surgeries were compared according to the four outcomes and total scores by using the Mann-Whitney U test (SPSS, version 21). A *P* value of ≤ 0.05 was considered statistically significant.

Surgical techniques

In AST, a 10-cm curved skin incision is made posterior to the condylar groove of the humerus. Care is taken to identify and protect the posterior branches of the medial

Table 1 Scoring system for study outcomes.

Outcome	Criteria	Scoring		
		0	1	2
Pain	VAS	Severe pain (8–10)	Slight pain (4–7)	No pain (0–3)
Sensory distribution (sensation)	Yale	None (0)	Decreased or abnormal (1)	Normal (2)
Muscle force	MRC	Poor (0–1)	Moderate (2–3)	Good (4–5)
Muscle atrophy	Clin	Severe	Moderate	None

Clin, according to individual clinician; MRC, Medical Research Council scoring; VAS, visual analogue scale; Yale, Yale sensory scale.

Figure 2 Posterior branches of the medial antebrachial cutaneous nerve.

Figure 3 A trough in the flexor and pronator musculature in which the ulnar nerve was laid.

antebrachial cutaneous nerve (Fig 2). The subcutaneous tissues are divided and the nerve is identified at the medial epicondyle immediately proximal to its entry into the cubital tunnel. The cubital tunnel retinaculum or arcuate ligament of Osborne is split and frees the nerve. Proximally, the nerve is followed to divide the intermuscular septum and the

Struthers' arcade. Distally, the release is continued as the nerve passes through the two heads of the flexor carpi ulnaris muscle to ascertain complete decompression. The ulnar nerve is thereafter dissected from the ulnar groove bed and transposed to a position anterior to the medial epicondyle. It is then followed by remaining in the subcutaneous bed, together with a fascial sling raised from the muscle fascia sutured from below to the dermis by using non-absorbable sutures. The course of ulnar nerve should be in a straight direction with no angulation.

In AIT, the same initial procedure is used for anterior transposition of the nerve. A 5mm deep trough is created in the flexor pronator mass distal to the epicondyle in line with the nerve (Fig 3) then the nerve is anteriorly transposed. To provide a soft, well-vascularised bed for the ulnar nerve, all fibrous septa between bellies of the flexor pronator mass at this level must be excised. With the forearm fully pronated and the elbow flexed 90 degrees, the flexor pronator fascia is repaired over the nerve.¹⁰ Subsequent to surgery, the arm is kept in a long arm dressing with the elbow fixed at 90 degrees and forearm in mid-pronation for a four-week period. Active range of motion starts at four weeks with interval splinting. At six weeks, a passive range of motion is started, together with a strengthening programme.¹¹

Results

There were 34 males and 6 females in the AIT group and 33 males and 10 females in the AST group. The AIT group showed a mean of age of 32.1 ± 10.5 compared with 34.8 ± 12 in the AST group. The patients undergoing AIT showed a significant improvement in all outcomes (pain, sensation, motor recovery and atrophy) after the surgery ($P = 0$); although those undergoing AST only experienced an improvement in pain and sensation after surgery ($P = 0$). Comparing the two surgeries, we found that there was a higher total satisfaction with AIT compared with AST ($P = 0$). When we independently compared each outcome in the two groups, we found that the muscle force recovery significantly improved in the AIT group compared with AST group ($P = 0$).

Discussion

To date, there has been little agreement on the appropriate surgical management of cubital tunnel syndrome. For operative treatment, there are two principle surgical procedures: decompression (simple decompression) and transposition. The latter is subdivided into subcutaneous, intramuscular, and submuscular transpositions, depending on the position in which the ulnar nerve is placed.² Thin patients are prone to repeated minor traumas after AST.¹² Osterman et al.¹³ pointed out that if AST fails, submuscular transposition is used to provide an unscarred bed for the ulnar nerve. In spite of numerous comparative retrospective reports of these procedures, no comparison between AST and AIT has been made. Lima et al. (12) showed a significant improvement in sensory and motor deficits and concluded that AST is a safe, simple and effective technique for the treatment of ulnar

nerve compression at the elbow. Zarezadeh et al.¹⁴ studied the comparison between AST and anterior submuscular transposition and demonstrated that anterior submuscular transposition reduced pain levels in 21 patients (87.5%) compared with 8 (33.3%) in AST ($P < 0.05$); no significant differences were found between the two groups in sensation ($n = 11$, 45.8% vs. $n = 12$, 50%), muscle force ($n = 17$, 70.8% vs. $n = 15$, 62.5%) and muscular atrophy ($n = 15$, 62.5% vs. $n = 17$, 70.8%; $P > 0.05$). Vigasio⁹ showed that, in intractable cubital tunnel syndrome, anterior deep transposition has a lower failure rate than AST. Jaddue et al.⁵ showed that AST of the ulnar had a shorter incision, shorter operative time, less postoperative pain, fewer postoperative complications and better outcome in moderate cubital tunnel syndrome compared with submuscular transposition. Lascar et al.¹⁵ assessed 53 patients with cubital tunnel syndrome undergoing AST with a follow-up of 32 months and concluded that AST is an effective treatment for the disease; however, the results were less satisfactory in the presence of a thoracic outlet syndrome. Caputo et al.¹⁶ argued that AST can be an effective treatment for recurrent cubital tunnel syndrome. The authors assessed 20 patients undergoing AST with a follow-up of two years and showed that 15 patients experienced a good or excellent outcome compared with 5 patients with a fair or poor outcome. Siegel¹⁷ preferred submuscular transposition for cases with failure of previous AST and those who are very thin, in whom the nerves were prominent under the skin. Leone² showed early clinical improvement in 77% of patients undergoing AIT. Dellon⁶ assessed five common surgical techniques for the treatment of cubital tunnel syndrome and showed that for a severe degree of compression, AIT produced the fewest excellent results and the most recurrences. Zlowodzki⁷ showed no differences in motor nerve-conduction velocities or clinical scores among patients with, on average, moderate to severe symptoms undergoing simple nerve decompression and nerve transposition. Submuscular transposition should be used for more severe neuropathy in cases with muscular atrophy. Zlowodzki et al.⁷ performed a meta-analysis of four randomised clinical trials comparing simple decompression with submuscular and subcutaneous anterior transposition of the ulnar nerve and demonstrated no difference in clinical outcome scores (effect size -0.04 ; 95% confidence interval -0.36 to 0.28], $P = 0.81$) and motor nerve-conduction velocities. Gay and Love¹⁸ reported a 70% satisfactory result in a series of 95 patients treated using Adson's technique over 25 years, although only 20 patients were seen for follow-up. Chan et al.¹⁹ reported 49 cases undergoing AIT with acceptable results. Kleinman and Bishop¹¹ argued that AIT is easy and effective, based on their experience with 45 cases, reporting good and excellent results in 87% of patients. Glowacki and Weiss²⁰ reported that 87% of patients with cubital tunnel syndrome experienced improvement after AIT. Roland et al.²¹ showed that for those with McGowan Grade 3 (severe) symptoms, patients with AIT experienced the best outcome compared with those with simple decompression and anterior submuscular transposition. Bimmler et al.²² pointed out that simple decompression of the ulnar nerve should be carried out in all cases without cubital (sub)luxation of the

nerve; nevertheless, those with a tendency towards cubital (sub)luxation of the ulnar nerve should be treated by submuscular anterior transposition.

Conclusion

There is no general consensus on the best surgical technique in the treatment of cubital tunnel syndrome. However, AIT has been highly regarded in this treatment. From the findings of the current study, we consider that AIT is a better procedure for treatment of cubital tunnel syndrome compared with AST, especially for the motor recovery of the ulnar nerve.

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