ORIGINAL ARTICLE

Comparison of anterior subcutaneous and submuscular transposition of ulnar nerve in treatment of cubital tunnel syndrome: A prospective randomized trial

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Background: This study was designed to compare two methods of surgery, anterior subcutaneous transposition (ASCT) and anterior submuscular transposition (ASMT) of the ulnar nerve in treatment of cubital tunnel syndrome. **Materials and Methods:** This randomized trial study was conducted from October 2008 to March 2009 in the Department of Orthopedic Surgery at University Hospital. Forty-eight patients with confirmed cubital tunnel syndrome were randomized in two groups, and each patient received one of two different surgical treatment methods, either ASCT (n = 24) or ASMT (n = 24). In the ASCT technique, the ulnar nerve was transposed and retained in the subcutaneous bed, whereas in the ASMT, the nerve was retained deep in the transected muscular complex, near the median nerve. Patient outcomes, including pain, sensation, muscle strength, and muscle atrophy were compared between groups. **Results:** The two groups were similar in baseline characteristics. However, those treated with ASMT had a statistically significant reduction in their pain levels compared with ASCT (21 (87.5%) vs 8 (33.3%), $P < 0.05$). There were no statistically significant differences between the two groups relative to sensation (11 (45.8%) vs 12 (50%)), muscle strength (17 (70.8%) vs 15 (62.5%)), or muscle atrophy (15 (62.5%) vs 17 (70.8%)) ($P > 0.05$). **Conclusions:** Our results indicate that ASMT are more efficient than ASCT for managing cubital tunnel syndrome. In patients who had ASMT, there were significant reductions of pain compared with ASCT.

Key words: Cubital tunnel syndrome, subcutaneous, submuscular, transposition

INTRODUCTION

Ulnar compressive neuropathy is the second most common nerve compression in the upper extremity. In contrast with carpal tunnel syndrome, numerous operative procedures have been described for the treatment of cubital tunnel syndrome; however, the best operative intervention remains controversial.[1-10] The basic surgical issues are whether the nerve should be transposed or not, and, if the transposition is performed, which location has the better conditions for placing the nerve. Three kinds of transpositional surgical techniques exist, subcutaneous, submuscular, and intramuscular, and each technique has advantages and disadvantages.

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An advantage of Anterior Subcutaneous Transposition (ASCT) is the reduction of tension on the nerve due to its new position, and the disadvantages include moderate perioperative morbidities, tenderness of the surgical site, postoperative immobilization, significant surgical scarring, and the new, superficial position of the nerve.[11-19] The advantage of Anterior Submuscular Transposition (ASMT) is that the nerve is repositioned to a location that is well perfused and well protected without tension, and the disadvantages are the same as those associated with ASCT.[20] Even though there are some reports that compare these two surgical methods, disagreement and controversy exist concerning which is the better technique. This study was designed to compare two methods of surgery, ASCT and ASMT of the ulnar nerve in treatment of cubital tunnel syndrome.

MATERIALS AND METHODS

This randomized trial study was conducted from October 2008 to March 2009 in the Department of Orthopedic Surgery at Al-Zahra University Hospital (Isfahan University of Medical Sciences), Isfahan, Iran.

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Patients with confirmed cubital tunnel syndrome (according to clinical and paraclinical preoperative assessments) were enrolled in the study. Exclusion criteria included deformity or distortion of the cubital tunnel due to previous trauma to the elbow and recurrent cubital tunnel syndrome after previous surgery. Finally, 55 patients were initially enrolled in the study. They were 25 to 60 years old, approximately half of them were hand dominant, they did not take special medications before surgery and sever patients had atrophy. The Ethics Committee of Isfahan University of Medical Sciences approved the study protocol and all patients gave informed consent prior to the study, which was authorized by the local Scientific Ethical Committee of Isfahan University of Medical Sciences, Isfahan, Iran, and was performed in accordance with the ethical standards of the 1964 Declaration of Helsinki as revised in 2000. The study was registered at ClinicalTrials.gov (Identifier: NCT01109901).

After acquiring biographic data, such as age and gender, based on a random table numbers, generated by the random allocation software,[21] the principal investigator (HSh) allocated patients into two groups of ASCT and ASMT and the patients were treated by a single orthopedic surgeon. According to clinical and paraclinical tests, sever and moderate patients and mild group that did not respond to conservative treatment were operated. Careful orthopedic examination assessments including elbow flexion test and Tinel sign and EMG/NCV as paraclinical test were conducted before surgery to determine the patients' severity of pain, deficit of sensation, muscular strength, and muscular atrophy. As necessary, significant cervical spine and shoulder diseases were ruled out by clinical examination and Magnetic Resonance Imaging.

Surgical technique

As the ASCT technique was described by Osborne, the subcutaneous tissues were dissected toward the medial epicondyle anteriorly to create a subcutaneous area where the ulnar nerve could be placed. After transposing the ulnar nerve, nerve was kept with underlying muscle fascia, which was sutured from below to the dermis using non-absorbable sutures. After ensuring that there was no tension, compression, or kinking of the nerve, the skin was sutured and a soft dressing and an elastic bandage were applied.

In the submuscular transposition technique, we used a modified Learmonth technique with Z-lengthening of the flexor-pronator mass. Without a tourniquet for blood control, a longitudinal incision posterior to the medial epicondyle was performed. The identification of the medial cutaneous nerve was noted. The ulnar nerve was identified and exposed up to the Medial Intermuscular Septum to avoid a possible future compression site. Distally, after division of the cubital tunnel retinaculum and Osborne's ligament, the nerve was led to the two heads of the flexor carpi ulnaris, and the nerve was then isolated with soft loops and immobilized. As accurately as possible, the extrinsic vessels and the epineural vascular arborization were preserved to avoid segmental ischemia of the nerve. Then, a lying position for the nerve was created by sectioning of the muscular pronator-flexor complex. The flexor-pronator mass insertion was incised in a Z shape. The nerve was transposed deep into the Z-shape incision provided in the flexor-pronator mass, and the muscular insertion was sutured above the nerve without traction, linking the two edges of the Z incision. Finally, the line of the transposed nerve was checked to ensure that there was no kinking or compression. The superficial tissues were closed in layers, and the cutaneous sutures were removed 15 to 18 days post-surgery. Antibiotic therapy was given for 24 to 48 hours and a splint was used postoperatively for 15 days.

Sensory disturbances were tested with Semmes–Weinstein filaments, and sensory deficits were categorized according to the Yale sensory scale. According to standard scoring system that was designed, the severity of sensation and function of the ulnar nerve was scored as follows: 0, no sensation; 1, decreased or abnormal sensation; 2, normal sensation.

To prevent bias, all patients underwent double-blind nerve conduction velocity studies, conducted by two neurophysiologists according to a standard protocol, before and after surgery. The nerve conduction studies were performed using a VIASYS Healthcare GmbH system. The ulnar nerve was stimulated 5 cm below and 10 cm above the elbow. The compound muscle action potential (CMAP) was recorded by bipolar surface electrodes from the abductor digitiminimi muscle, with the active electrode placed over the muscle belly. The reference electrode was fixed to the base of the fifth finger. The strength of the stimulus was increased until a maximum CMAP was recorded. Motor nerve conduction velocity studies were performed in all cases.

Pain was evaluated with a Visual Analogue Scale with scores of zero to ten (0 for no pain and 10 for intolerable pain) and then scored as follows: 0, severe pain (8-10); 1, slight pain (4-7); 2, no pain (0-3). During surgery, the area of compression was noted in all cases.

Muscle strength was evaluated with the grading system from the Medical Research Council, which is based on a scale of zero to five: 0, no muscle contraction; 1, flicker or trace of muscle contraction; 2, limb or joint movement possible only with gravity eliminated; 3, limb or joint movement against gravity only; 4, power decreased, but

limb or joint movement possible against resistance; 5, normal power against resistance. The results were scored as follows: 0, Poor (0-1); 1, Moderate (2-3); 2, Good (4-5).

Muscle atrophy was scored by one orthopedic surgeon as follows: 0, Severe; 1, Moderate; 2, none.

All patients were reexamined 12 months after surgery with the same examiner. All scores in four outcomes were added, and the total scores were rated as follows: 0-2, Poor; 3-4, Moderate; 5-6, Satisfactory; 7-8, Good. The desirable result in study was 5-8.

After the scores were collected, we used Chi-square test and the Mann-Whitney way to compare them statistically. The threshold value of $P = 0.05$ was used to provide sufficient evidence to reject the null hypothesis and state that the difference is statistically significant.

RESULTS

Participants' flow is shown in the CONSORT diagram in Figure 1. Of the 55 patients initially enrolled in the study, seven were not included in the final analysis. Of the four patients who have not met the inclusion criteria, two patients had distortion of the cubital tunnel due to previous trauma to the elbow and two patients were excluded due to recurrent cubital tunnel syndrome. A total of 48 patients were left in the final sample, 24 of whom received ASCT and 24 of whom received ASMT for cubital tunnel syndrome.

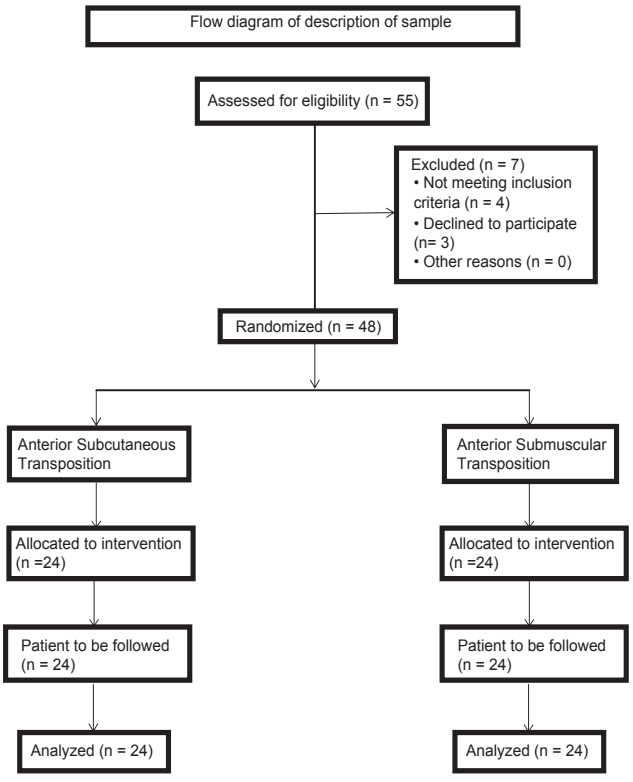

Figure 1: Participants' flow in the CONSORT diagram

There were 13 males in ASCT compared with 14 males in ASMT group. According to Chi-square test, there were no significant different outcomes between the two surgical techniques based on gender (P = 0.884). The mean of age of the ASCT group was 47.58 ± 12.1 years, and the mean age of the ASMT group was 47.41 ± 12.2 years, so there was no statistical difference between the two groups based on age ($P = 0.901$).

At the first pre-surgical examination, there were no statistically significant differences between the two groups with respect of sensory deficits, degree of pain, muscle atrophy, or muscle strength ($P > 0.05$) [Table 1]. The total scores in ASMT and ASCT were 22 and 23, respectively ($P > 0.05$), indicating that there were no significant differences between the two groups.

According to Chi-square test, the patients treated with ASMT had statistically significant pain reduction compared to the patients treated with ASCT (P = 0.0004) [Table 2].

After surgery, both groups had remarkably better sensation, and 90% of the patients in both groups had a score greater than 5, resembling the result on a study purpose basis. However, sensation, muscle strength, and muscle atrophy had numbering differences, and we were unable to find any statistically significant differences between them ($P = 1$, $P = 0.76$, and $P = 0.76$) [Table 2].

Considering the results that were obtained in these tests, we found desirable outcomes (total score ≥ 5) in 22 patients who had ASCT (91.7%). Their average score was 5.83. In the ASMT group, 23 patients (95.8%) had desirable outcomes (total score ≥ 5), and their average score was 6.66 [Table 3]. So, applying the Mann Whitney statistical assessment showed substantial difference between the outcomes for the two groups ($P = 0.023$).

DISCUSSION

Compression of the ulnar nerve at the cubital tunnel is the most common cause of numbness on the ulnar side of the hand. There are several surgical methods for treatment. In the present study, we compared the ASCT and ASMT techniques.

In this study, the randomized trial results indicate that submuscular transposition had better pain reduction than subcutaneous transposition. There were significant differences between the two groups in desirable result (total score ≥ 5). In addition, the results of the measurement of other outcomes, such as sensation, muscle strength, and

Table 1: Scoring of outcomes for the two methods preoperatively

Outcome	Anterior Subcutaneous Transposition			Anterior Submuscular Transposition			*P* value*
	0 (%)	1 (%)	2 (%)	0 (%)	1 (%)	2 (%)	
Pain	18 (75)	6 (25)	0	20 (83.3)	4 (16.7)	0	0.72
Sensation	8 (33.3)	15 (62.5)	1 (4.2)	8 (33.3)	15 (62.5)	1 (4.2)	1
Muscle strength	4 (16.7)	18 (75)	2 (8.3)	4 (16.7)	17 (70.8)	3 (12.5)	0.89
Muscle atrophy	1 (4.2)	18 (75)	5 (20.8)	0	18 (75)	6 (25)	0.58

Data are presented as number (percentage), * Chi-square with Yates' correction for continuity

Table 2: Scoring of outcomes for the two methods postoperatively

Outcome	Anterior Subcutaneous Transposition			Anterior Submuscular Transposition			*P* value*
	0	1 (%)	2 (%)	0	1 (%)	2 (%)	
Pain	0	16 (66.7)	8 (33.3)	0	3 (12.5)	21 (87.5)	0.0004
Sensation	0	13 (54.2)	11 (45.8)	0	12 (50)	12 (50)	1
Muscle strength	0	7 (29.2)	17 (70.8)	0	9 (37.5)	15 (62.5)	0.76
Muscle atrophy	0	9 (37.5)	15 (62.5)	0	7 (29.2)	17 (70.8)	0.76

Data are presented as number (percentage), *Chi-square with Yates' correction for continuity

Table 3: Total scores for anterior subcutaneous vs submuscular transposition

Method	Mean ± SD	Median	*P* value***
Preoperation			
ASCT*	2.91 ± 1.13	3	0.92
ASMT**	2.91 ± 1.10	3	
Postoperation			
ASCT*	5.83 ± 1.09	6	0.71
ASMT**	6.66 ± 1.34	7	

Data are presented as mean ± 1standard deviation and Median, *Anterior SubcutaneousTransposition, **Anterior Submuscular Transposition, ***Mann-Whitney test

muscle atrophy, indicated that there were no significant differences between the two groups.

The results indicated ASMT had better desirable result compared with ASCT. These results do not agree with those of Köse *et al*.,[22] Osterman and Davis,[23] or Asamoto *et al*.,[24] who concluded that subcutaneous ulnar nerve transposition is an excellent choice for the treatment of cubital tunnel syndrome. This difference may be because of differences in sample sizes and experience of surgeons. Our findings indicated that ASMT is superior to ASCT for treating this condition. These findings supported the Lee *et al*.'s findings which on a histological study basis using a rat model, the submuscular method of ulnar nerve anterior transposition displayed histologically healthier axons and less perineural scar tissue compared to the subcutaneous method.[25] Our findings showed that the postoperative pain may be more influenced by perineural nerve scaring compared with the depth of skin scar which have been made in operation room. Therefore, future more studies in determining the factors which influence the postoperative pain are warranted. In other three outcomes, sensation, muscle strength, and muscle atrophy, our findings agree with previous study results[22-24] which determined no significant differences between the two groups.

This study, which was based on scoring levels provided by the patients, showed that patients who had slight symptoms before surgery had the same level of symptoms after surgery. For patients who had moderate symptoms before surgery, ASMT was more effective. Unfortunately, the patients who had severe symptoms before surgery did not gain any noticeable advantage from either method. Comprehensively, this analysis showed that in patients who have average symptoms before surgery, the ASMT method produced the better outcomes and a lower incidence of recurrence of the pain. In patients with chronic or slight symptoms, there were no differences between the outcomes from ASCT and ASMT.

Our study has several strengths. Surgical procedures were standardized and all performed by the same surgeon. All patients were evaluated for each follow-up without any patient lost at final follow-up. Postoperative recovery, rehabilitation protocol, and medical prophylaxes were the same for both groups. Limitations of this study might be the low sample size and not being multicentric which may influence the results.

CONCLUSIONS

Our results indicate that ASMT are more efficient than ASCT for managing cubital tunnel syndrome. In patients who had ASMT, there were significant reductions of pain compared with ASCT.

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