CUBITAL TUNNEL SYNDROME: REVIEW OF 14 ANTERIOR SUBCUTANEOUS TRANSPOSITIONS OF THE VASCULARIZED ULNAR NERVE

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Abstract- Anterior transposition of the ulnar nerve is widely implemented for treatment of cubital tunnel syndrome. However, preservation of the extrinsic blood supply of the ulnar nerve may result in better clinical outcomes. Fourteen patients with cubital tunnel syndrome, 11 men and 3 women, were treated by anterior subcutaneous transposition of the ulnar nerve. The extrinsic blood supply of the ulnar nerve was preserved. The average age at the time of operation was 33 years. The average follow-up period was 44 months. Post-operative outcome assessment by an independent examiner was based on the modified Bishop rating system. Nine patients had excellent or good outcomes. Five patients had a fair outcome. There were no complications or recurrence of symptoms. Anterior subcutaneous transposition of the vascularized ulnar nerve is an effective method of surgical treatment for patients with cubital tunnel syndrome.

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Key words: Cubital tunnel syndrome, ulnar nerve, transposition

INTRODUCTION

Second only to carpal tunnel syndrome, ulnar nerve compression at the elbow region, cubital tunnel syndrome, is a common peripheral neuropathy of the upper extremity (1). Surgical options are divided broadly into three types of procedures, namely simple decompression, medial epicondylectomy and anterior transposition of the ulnar nerve. Simple decompression and medical epicondylectomy aim to preserve the vascularity of the nerve but traction still exists during flexion of the elbow (2, 3). Methods of anterior transposition including subcutaneous, submuscular, intramuscular and newly introduced subfascial (4), have been reported in literature. Subcutaneous transposition is easy to perform and facilitates early post-operative mobilization (5). This technique has been applied to both primary and revision surgery in cubital tunnel syndrome treatment (6). The extrinsic blood supply to the ulnar nerve at the elbow is typically sacrificed with a routine anterior transposition (2). Preservation of the extrinsic vasculature of the ulnar nerve is important in obtaining better clinical results (7).

We review the results of treatment of cubital tunnel syndrome using subcutaneous technique with vascular mesoneurium being preserved.

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MATERIALS AND METHODS

Fourteen patients who underwent a subcutaneous transposition of the vascularized ulnar nerve from 1996 to 2003 were retrospectively assessed. There were 11 men and 3 women, with a mean age of 33 (range 11-76) years. The operation was performed on 6 left and 8 right upper extremities. Etiologies included elbow deformities in 6, osteoarthritis in 2, idiopathic in four, one recurrent ulnar nerve

subluxation and one neurinoma. All the assessments were made by an independent examiner. Each patient was examined preoperatively and the following data were noted: age, sex, hand dominance, occupation and any possible causal factors.

The diagnosis of cubital tunnel syndrome was made on a typical history of pain and/or paresthesia in the ulnar nerve distribution of the hand, weakness of hand grip and loss of or diminished hand dexterity. Physical examination disclosed a positive Tinel's sign over the course of the ulnar nerve at the elbow in all patients. Proximal pathology was ruled out by cervical and shoulder examination. Postural signs which worsened when the arm was raised and Roos maneuver were routinely assessed. Furthermore, supraclavicular tenderness and a supra-clavicular Tinel's sign were noted. Thoracic outlet syndrome on the same side was diagnosed according to accepted criteria. Elbow radiographs were routinely obtained and electro-diagnostic tests were done in all the cases. Histories of previous trauma to or symptoms in the elbow region were noted.

Confirmation of the diagnosis was based on clinical examination (sensory deficit, abnormal two point discrimination along the distribution of the ulnar nerve, loss of intrinsic bulk and weakness of grip strength) and nerve conduction studies (NCS). Preoperatively the condition of the ulnar nerve was graded according to modified staging score system that was based on the staging criteria established by Dellon (Table 1). None of the patients had positive history for systemic diseases.

The main reasons for operative management were (a) symptomatic ulnar neuropathy, without neurological deficit that has failed to respond to adequate non-operative treatments (including nighttime splinting of the elbow in extension and the use of non-steroidal anti-inflammatory agents for 6 weeks), and (b) an objective neurological deficit.

Each patient was seen at 1 week, 3 weeks and 3 months after surgery and at final review. Follow-up averaged 44 months (range 7-80 months). Post-operative outcome assessment was based on modified Bishop scoring system (Table 2). Patients were assigned outcome status of excellent, good, fair or poor on the basis of the final follow-up. The preoperative assessments were repeated.

Table 1. Dellon's staging of ulnar compression at the elbow

Mild
Sensory
Intermittent paresthesia
Vibratory perception increased
Motor
Subjective weakness, clumsiness, or loss of coordination
Tests
Elbow flexion test, Tinel sign, or both are positive
Moderate
Sensory
Intermittent paresthesia
Vibratory perception normal or decreased
Motor
Measurable weakness in pinch or grip strength
Tests
Elbow flexion test, Tinel sign, or both are positive
Finger crossing may be abnormal
Severe
Sensory
Paresthesia are persistent
Vibratory perception decrease
Abnormal two point discrimination
Motor
Measurable weakness in pinch or grip strength plus muscle atrophy
Tests
Elbow flexion test, Tinel sign, or both are positive
Finger crossing usually abnormal

All patients were asked if they were satisfied with the surgery result and if positive whether they will suggest this method to other patients having cubital tunnel syndrome.

Surgical technique

With the patient supine under general anaesthesia and tourniquet control, a curvilinear skin incision is made posterior to the medial epicondyle, extending from 7 cm above to 5 cm below the condyle. The branches of the medial cutaneous nerves of the arm and forearm crossing the incision are protected during the blunt dissection. After locating the ulnar nerve below the fascia proximally, the arcade of Struthers and distal part of the medial intermuscular septum is excised. The cubital tunnel is then unroofed, and the nerve dissected distally to free it from posterior aspect of the condylar groove.

Table 2. Modified Bishop rating system

	Points
Satisfaction	
Satisfied	2
Satisfied with reservation	1
Dissatisfied	0
Improvement	
Better	2
Unchanged	1
Worse	0
Severity of residual symptoms (pain, paresthesia, dysesthesia, weakness, clumsiness)	
Asymptomatic	3
Mild, occasional	2
Moderate	1
Severe	0
Work status	
Working or able to work at previous job	1
Not working because of ulnar neuropathy	0
Leisure activity	
Unlimited	1
Limited	0
Strength	
Intrinsic muscle strength normal (M5)*	2
Intrinsic muscle strength reduced to M4	1
Intrinsic muscle strength less than or equal to M3	0
Sensibility (static two-point discrimination)	
Normal (≤ 6 mm)	1
Abnormal (> 6 mm)	0
Total	12

* Medical council grading.

Inferiorly, it is traced deep to the fascia of Osborne and between the two heads of the flexor carpi ulnaris. The arcade of Osborne, the fascia or the extensor carpi ulnaris muscle and its deep aponeurosis are then divided longitudinally, sparing the motor branches. It is then possible to transpose the ulnar nerve anteriorly without creating more proximal areas of impingement. Once the nerve is identified, it is isolated with a soft rubber loop that is used to minimize focal pressure on the nerve during gentle retraction (Fig. 1). At operation, the extrinsic vessels including the superior ulnar collateral artery (SUCA) the inferior ulnar collateral artery (IUCA) and the posterior ulnar recurrent artery (PURA) are evaluated (Fig. 2).

Fig. 1. A soft rubber loop is used for gentle retraction.

Attempts to preserve as much of the segmental blood supply as possible is made so that they remained with the nerve as it is displaced anterior to the epicondyle. Transverse perforating vessels or the SUCA and PURA are coagulated before transposition. The nerve now lies on the anterior aspect or the superficial aponeurosis of the medial epicondylar muscles without tension. One 3-0 catgut suture is used to approximate the adipose tissue from the anterior flap to the medial epicondyle and to prevent return of the nerve back to the epicondylar groove.

The course or the transposed ulnar nerve is then checked to ensure there is no kinking or compression. Furthermore, the position of the nerve is evaluated through the full arc of elbow motion. A low-pressure suction drain is inserted. The skin and subcutaneous tissue are approximated in the usual way.

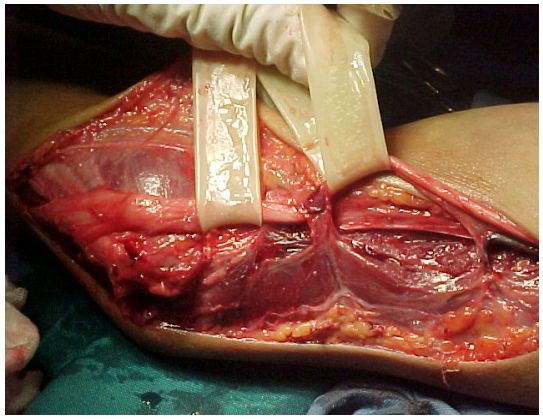

Fig. 2. Segmental blood supply of the ulnar nerve is preserved at operation as possible.

A soft dressing is applied and the elbow is immobilized for 2 weeks postoperatively in 90° flexion. Subsequently, patient is allowed to progressively begin full active range of motion.

Analysis of Data

SPSS version 10 software was used for descriptive analysis of the data. The relationships between various parameters were analyzed using Chi square test. *P* value less than 0.05 was considered significant.

RESLUTS

Over a seven-year period from 1996 to 2003, 27 cubital tunnel syndromes underwent surgery in our department. Thirteen cases were excluded from the study as they had been treated by other surgeons or had not been treated with subcutaneous transposition method. Fourteen remaining cases were all assessed with a mean follow-up of 44 months (range 7-80). There were 11 men and 3 women whose mean age was 33 (range 11-76) years. The mean body mass index (BMI) was 25.5 (range 21-31). Subcutaneous transposition was performed as a primary surgery in all patients. No etiologic factor was found in 4 cases (28%) whereas previous trauma had occurred in 8 cases (57%). There was no systemic disease as predisposing factor. The cubital tunnel syndrome involved the dominant side in 12 cases and the non-dominant side in just 2. None of our cases were bilateral. The data of these 14 patients are depicted in table 3. Paresthesia was present before surgery in 9 cases, hypoesthesia in 13 and pain in 6. Objective hand weakness was present in 12 patients, whereas intrinsic atrophy was present in 11. Tinel's sign was positive in all cases. Preoperatively, all patients were graded based on Dellon's classification (Table 1). Eleven, 2 and 1 cases were considered as severe, moderate and mild, respectively. Preoperative electrodiagnostic studies were done in all cases but it was not available for all patients. In one case the preoperative clinical examination indicated bilateral thoracic outlet syndrome confirmed by electrodiagnostic study.

Range of motion of elbow was full in 7 patients. Others had a varying degree of limited range of motion (Table 3).

Motor and sensory function improved in most cases. Four patients who were graded as having severe neuropathy were free of symptoms at follow up. Patients with a good or excellent outcome had an average age of 22 years (range 11-44 years) compared with the patients with fair outcome, who had an average age of 39 years (range, 20-76 years). There was a trend for fair outcomes to be associated with age.

Table 3. Patients' data

Case	Sex	Age	Pre-op staging	Post-op score	NCV post-op	Follow (month)	Result	Range of motion	2PD post-op (mm)	Site	Satisfied	Job
01	M	26	Severe	12	37.6	34	E	15-125	5	L	Y	Farmer
02	M	30	Severe	6	43	74	F	10-90	9	R	Y	Worker
03	M	20	Severe	6	45	17	F	10-110	50	R	Y	Worker
04	M	11	Severe	12	33	62	E	Full	5	L	Y	Handballist
05	F	37	Severe	4	20	13	F	Full	40	R	N	Housekeeper
06	F	37	Severe	12	51.7	67	E	Full	6	R	Y	Housekeeper
07	M	34	Severe	4	21	49	F	30-120	20	R	Y	Technician
08	M	76	Severe	6	40	66	F	20-110	6	R	Y	Writer
09	F	41	Moderate	7	42.6	69	G	Full	8	R	N	Housekeeper
10	M	44	Severe	8	37	80	G	40-110	6	R	Y	Worker
11	M	19	Mild	10	47	26	E	Full	5	L	Y	Solder
12	M	41	Severe	8	40	43	G	Full	11	L	Y	Worker
13	M	24	Moderate	12	50	7	E	Full	6	L	Y	Operator
14	M	23	Severe	11	40	15	E	30-110	6	L	Y	Student

Abbreviations: op, operation; NCV, nerve conduction velocity; 2PD, two point discrimination; M, male; F, female; E, excellent; G, good; F, fair; P, poor; L, left; R, right, Y, yes; N, no.

Table 3. (continued) Patients' data

Case No.	Reason for TUN	Intrinsic atrophy pre op.	Intrinsic atrophy post op.	Paresthesia pre op.	Paresthesia pre op.	Hypoesthesia pre op.	Hypoesthesia post op.	Pain pre op	Pain post op	Moderate activity limited pre op	Moderate activity limited post op	Weakness Pre op	Weakness Post op
01	NOLC CUB Val	Y	N	Y	N	Y	N	N	N	Y	N	Y	N
02	NOLC CUB Val	Y	Y	Y	N	Y	N	Y	N	Y(S)	Y	Y	Y
03	NOLC CUB Val	Y	Y	N	N	Y	Y	Y	N	Y	N	Y	Y
04	NOLC CUB Val	Y	N	N	N	Y	N	N	N	Y(S)	N	Y	N
05	IDIOP	Y	Y	N	N	Y	Y	N	N	Y(S)	N	Y	Y
06	IDIOP	Y(mild)	N	N	N	Y	N	N	N	Y(S)	N	Y	N
07	NOLC CUB VAL	Y	Y	Y	N	Y	Y	N	N	Y	Y	Y	Y
08	NOLC CUB VAL	Y	Y	Y	N	Y	N	N	N	N	N	Y	Y
09	Neurinoma	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	N
10	OA	Y	Y(IMP)	Y	N	Y	N	N	N	Y(S)	N	N	Y
11	Recurrent ulnar dislocation	N	N	Y	Y(IMP)	N	N	Y	N	Y	N	Y	N
12	IDIOP	Y	N	Y	Y(IMP)	Y	Y(IMP)	Y	N	Y	N	YN	N
13	IDIOP	N	N	N	N	Y	N	Y	N	N	N	Y	N
14	OA	Y(mild)	N	Y	N	Y	N	N	N	Y	N	Y	N

Abbreviations: TUN, transposition of the ulnar nerve; op, operation; NOLC, nonunion of lateral condyle of humorous; CUB Val, cubitus valgus; OA, osteoarthritis; Y, yes; N, no; S, somehow limited activity remained; IDIOP, idiopathic; IMP, improved with operation.

However it was not statistically significant. Post-operatively, 45% of atrophies were resolved. Post-operative static two-point discrimination was less than or equal to 6 mm in 8 cases.

Results were graded based on the modified Bishop rating system (Table 2). Six were graded as excellent (four scored 12, one scored 11, one scored 10) and three were graded as good (scores of 7 and 8). No case was evaluated as poor. No significant correlation was found between stage of ulnar neuropathy and surgical outcomes. Twelve patients were satisfied with surgery result, and stated they would encourage others with the same problem to choose this operative option.

Each stated that they would undergo the surgery again. One of the two unsatisfied patient complained right upper limb pain. Thoracic outlet syndrome was diagnosed in the review follow up. Another was a housekeeper whose cubital tunnel syndrome was diagnosed as idiopathic. After 7 months follow up she complained of a still partial disability to do house work, she also mentioned that the numbness had not been resolved.

The scar was painless in all cases. There were no major complications and no recurrences of symptoms in this series. A residual Tinel's sign was found in 3 patients.

DISCUSSION

Cubital tunnel syndrome is a well recognized entity. Surgical options are divided broadly into three types of procedures, namely simple decompression, medial epicondylectomy and anterior transposition of the ulnar nerve. Several studies have demonstrated that the outcome of cubital tunnel syndrome surgery is affected by the duration and severity of the symptoms as well as advanced age, rather than the choice of surgical technique (8, 9, 10).

Anterior transposition is preferred for patients with bony deformity. Our study population consisted of patients with elbow deformity (43%) and elbow osteoarthritis (14%). We preferentially selected subcutaneous anterior transposition of vascularized ulnar nerve as an operative treatment choice, based on surgical experience and optimal treatment option for patients. Our objectives in this study were to document symptom resolution and ensure no objective decline in functional outcome. This method is applicable to ulnar nerve entrapment at any stage. Failure of subcutaneous transposition is often due to technical errors (11) and it is important to avoid creating a new compression site (12).

However, recent studies reported that subcutaneous transposition had some concerns of the transferred ulnar nerve. Some authors criticized for decreasing the blood supply of the ulnar nerve (1, 13). Decrease of blood supply of the nerve may delay nerve recovery and induce poor clinical results.

Vascular pedicle of the ulnar nerve is routinely sacrificed during transposition (2, 13, 14). This may cause an ischemic threat to nerve fibers, which are oversensitive to oxygen pressure. The extrinsic blood supply can be preserved during transposition (7, 15). Asami reported that the postoperative nerve conduction velocity and clinical results were better in the group with preservation of the extrinsic vessels of the nerve than in the group without this procedure.

Fourteen cases of cubital tunnel syndrome underwent anterior subcutaneous transposition, among which 11 were graded as severe. The point about this study is that, 57% of the cases are posttraumatic (6 elbow deformities, 2 osteoarthritis). Among 79% of the population having severe ulnar neuropathy, anterior subcutaneous transposition led to complete recovery in four cases (more than 36%), and no poor result has been indicated.

Furthermore, subcutaneous anterior transposition did not result in either objective or subjective morbidity. There were no complications, recurrences, and aggravations of the preoperative symptoms. Instability and slipping back of the nerve to the cubital tunnel were not observed.

Our evaluation clearly shows that operation resulted in the resolution of preoperative sign and symptoms, including ring and small finger paresthesias and hypoesthesia, pain, hand weakness and atrophy. Moreover it has been quite successful in restoring daily activity in a noticeable number of patients (75%). None of our patients were too thin for subcutaneus transposition (mean BMI 25.5). Only two patients were not satisfied with the surgery results. We believe that a short follow up period of one of the patients could have been responsible for her dissatisfaction and fair surgery result. In this case symptoms will eventually resolve. Nevertheless, there is no way to make such a prediction.

There are some concerns about the atrophy evaluation and its recording. Wasting of dorsal interosseous or hypothenar muscles has not been the same in all individuals in this project. In early stages atrophy is mild and can be diagnosed through a careful physical examination. On the other side, moderate and sever atrophic muscles could have been observed as time passes. We did not discriminate between severities of atrophy, so this may be the factor making the atrophy recovery surprising (45%). There is a considerable bias at this part in this project and most of other studies. We believe that the statistical analysis is limited by the low number of the operated cases. Lack of precise record of patients' data is another limitation encountered during study. The average follow-up was 44 months and some of our patients may again develop recurrent symptoms in the future. Furthermore, the Dellon's and outcome grades were retrospectively assigned for 9 patients. Although we believe the assessment was done accurately and conscientiously, small inconsistencies are always possible.

Subcutaneous transposition of vascularized ulnar nerve is a simple and reliable procedure that can easily decompress the nerve. This procedure can also

be applied to patients with old fractures dislocations causing elbow deformity. We believe that preservation of the extrinsic vessels is necessary for better results. In addition, because of the study design, one can not absolutely recommend the subcutaneous technique for cubital tunnel syndrome. A prospective randomized study comparing the various methods would be the most appropriate approach.

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