

Subcutaneous vs Submuscular Ulnar Nerve Transposition in Moderate Cubital Tunnel Syndrome

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Abstract: *Background:* The surgical treatment of Cubital tunnel syndrome (CubTS) is still a matter of debate. No consensus exists about the necessity of anterior transposition of the ulnar nerve after decompression. However, this technique is fairly common in clinical practice.

Material and Methodology: In the present study we compared the operative technique (incision length, operative time), postoperative care (postoperative pain and complications) and the outcome between subcutaneous transposition and submuscular transposition of the ulnar nerve as two surgical modalities in treating moderate CubTS.

Between March 2004 and March 2007, twenty six patients with moderate CubTS (according to Dellon's grading system) were stratified according to age and gender into these two surgical techniques. The two groups were prospectively followed up 2 weeks, 6 months and 12 months postoperatively by the same observer and the operation outcome was assessed using the Bishop rating system.

Results: We found that the subcutaneous transposition of the ulnar nerve was associated with shorter incision, shorter operative time, less postoperative pain, less postoperative complication and better outcome compared with the submuscular transposition.

Conclusion: The authors recommend the subcutaneous technique when considering anterior transposition of the ulnar nerve in treating moderate CubTS.

Keywords: Subcutaneous transposition, submuscular transposition, cubital tunnel, ulnar nerve, outcome.

INTRODUCTION

Motor innervation of the intrinsic muscles of the hand is predominantly provided by the ulnar nerve. Entrapment, impingement, stretching and friction of the ulnar nerve in the vicinity of the cubital tunnel of the elbow may give rise to focal neuropathy with subsequent disturbance of hand function. This condition is known as cubital tunnel syndrome (CubTS) and is considered as the second most common compressive neuropathy of the upper extremity after carpal tunnel syndrome [1-3].

Neuropathy in CubTS is mostly due to alteration in the volume and the pressure of the cubital canal with flexion and extension. Elbow flexion causes traction and excursion of the ulnar nerve leading increased intraneural pressure [4, 5]. Prolong flexion of the elbow may lead to neuropathy and demyelination which is commonly located in the bulbous swelling proximal to the entry of the nerve into the cubital tunnel [6].

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

CubTS. The severity of symptoms can be graded according to Dellon's grading system into mild (intermittent parasthesia and subjective weakness), moderate (intermittent parasthesia and measurable weakness) and severe (permanent parasthesia and palsy) [7].

The differential diagnoses of CubTS include cervical radiculopathy, Pancoast's tumors and lesions of brachial plexus as well as ulnar nerve compression at other sites e.g. Guyon's canal.

Occasionally old age can produce intrinsic hand atrophy and dysfunction [3, 8].

Non-operative treatment of CubTS in selected cases may provide symptomatic relief. In patients with early symptoms, activities and positions which produce friction from repetitive elbow movements or stretching and compression of the nerve from excessive elbow flexion should be avoided [9]. For constant pain and parasthesia, a rigid thermoplastic splint positioned in 45° of flexion can be used to decrease pressure on the ulnar nerve. As symptoms subside, patients can wear the splint just at night [10].

For operative treatment, different surgical procedures are described. These can be divided into two categories, decompressive procedures and transposition procedures. Decompressive procedures such as simple decompression with or without medial epicondylectomy address

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decompression of the nerve without mobilizing it. The transposition procedures mobilize the nerve anteriorly into a more protected location. The latter category can be further subdivided into subcutaneous, intramuscular, or submuscular depending on the position in which the ulnar nerve is placed [11].

The aim of the present study was to compare the results of ulnar nerve decompression with subcutaneous transposition to ulnar nerve decompression with submuscular transposition as two surgical modalities in treating moderate CubTS.

MATERIAL AND METHODOLOGY

During the period between March 2004 and March 2007, patients with CubTS who were presented to us were considered for inclusion in the study. The clinical assessment of these patients included analysis of symptom duration and severity. Physical examination of the affected limb was conducted to assess the sensory and motor functions of the ulnar nerve. For the sensory function, sensation along the ulnar nerve dermatomal supply was evaluated for any parasthesia and abnormal vibratory perception using a tuning fork of 128 Hz applied at the head of the 5th metacarpal bone. For the motor function, muscle power of abducting the little finger against resistance (abductor digiti minimi muscle) and adducting the thumb against resistance (adductor pollicis muscle and the presence of Froment's sign) were evaluated using the medical council grading scale (grade 0: no movement, grade I: only a flicker of movement, grade II: movement with gravity eliminated, grade III: movement against gravity, grade IV: movement against resistance, grade V: normal power). Tinel's and elbow flexion tests were performed. To exclude other diagnoses, plain X-Ray of the cervical spine and chest was done in all patients. The diagnosis was confirmed by electromyography (EMG) where conduction velocity less than 50 m/sec considered as a positive finding. The severity of CubTS was evaluated by using Dellon's grading system [7].

Twenty six *consecutive* patients with moderate CubTS (according to Dellon's grading system) were included in the study. These patients were stratified according to age (2 years margin) and gender into the subcutaneous group (n = 13, M:F = 10:3, mean age 34 years) and the submuscular group (n = 13, M:F = 10:3, mean age 34 years).

In the subcutaneous group the ulnar nerve was placed below the subcutaneous fat of the arm and forearm while in the submuscular group the ulnar nerve was placed in the interval between the two heads of flexor carpi ulnaris beneath the flexor pronator origin. The surgeries in both groups were performed *equally* by two surgeons (DJ and SS). Postoperatively, patients were hospitalized for one to two days with arm elevation and were supplied with a collar and cuff sling when discharged. Patients' postoperative follow-up visits were carried out prospectively by the same independent observer at the outpatient department at 2 weeks, 6 months and 12 months.

The *primary outcome* of the studied surgical techniques included incision length, operative time, postoperative pain and complications while the *secondary outcome* was

assessed 12 months postoperatively using the Bishop rating system [12] (Table 1).

Table 1. The Outcome of the Operations was Assessed 6-12 Months Postoperatively Using the Bishop Rating System as Fellows: Excellent: 10-12 Points, Good: 7-9 Points and Poor: 0-6 Points

Variable	Points
Satisfaction	
Satisfied	2
Satisfied with reservation	1
Dissatisfied	0
Improvement	
Better	2
Unchanged	1
Worse	0
Severity of residual symptoms (pain, parasthesia, weakness, clumsiness)	
Asymptomatic	3
Mild	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

The postoperative pain was evaluated at the 2 weeks follow-up visit according to the following pain grading system: Grade I (mild) pain that can be easily ignored, Grade II (moderate) pain that cannot be ignored and interferes with function, Grade III (severe) pain that is present most of the time and demands constant attention and Grade IV (excruciating) totally incapacitating pain [12, 13] and also by using the Visual Analogue Scale (VAS) consisting of a 10 cm long line, where 0 represented no pain and 10 the worst imaginable pain. Stitches and sling were removed at that visit to allow increasing range of motion exercises. All patients received physiotherapy instructions and intense physical therapy is started 6 weeks postoperatively.

Statistics and ethics: Data were analyzed using the Statistical Package for Windows version 10.0 program (SPSS, Inc., Chicago, IL, USA). The median was used for evaluation of VAS whereas the Mann-Whitney U test was used for the comparison of VAS measurements and the

Bishop rating system between the studied groups. Differences were considered to be significant at a level of $p < 0.05$.

The work was approved by the regional ethical committee.

RESULTS

Male : female ratio was 3.3:1 with mean age of 34 years. More than 55% of the patients were at the age of 30-39 years (Table 2). The clinical manifestations of our patients are summarized in Table 3. Elbow deformity (mainly valgus) was found in 42% of patients while no obvious cause to CubTS (idiopathic) was found in 34% of patients. History of previous blunt trauma to the elbow was reported by 24% of patients.

Table 2. The Age Distribution of the Included Patients Shows that Nearly 75% of them were at the Age Interval 30-49 Years

Age (Year)	No.	%
< 20	2	8%
20-29	4	15%
30-39	14	54%
40-49	5	19%
≥ 50	1	4%
Total	26	100%

Table 3. The Percentage of the Presented Clinical Manifestations in Both Groups

Symptoms and Signs	No.	%
Intermittent parasthesia	26	100%
Decreased vibratory perception	19	73%
Grip weakness	24	92%
Positive Tinel’s sign	26	100%
Positive elbow flexion test	26	100%

Table 4 shows a comparison between the two groups regarding the operative techniques and postoperative follow-up.

Table 4. The Subcutaneous Technique was Associated with Favorable Operative and Postoperative Aspects

Variables	Subcutaneous	Submuscular
Length of incision	12-14 cm	15-20 cm
Mean operative time	≤ 30 minutes	≥ 45 minutes
Postoperative pain	Mild. VAS = 2.7	Moderate. VAS = 4.4 ($p < 0.05$)
Postoperative wound infection	(0/13, 0%)	(1/13, 7%)

The results of Bishop rating system (Table 5) show that the outcome in the subcutaneous group was excellent in 54% (n = 7), good in 38% (n = 5) and poor in 8% (n = 1) while the outcome in the submuscular group was excellent in 15% (n = 2), good in 47% (n = 6) and poor in 38% (n = 5), $p = 0.035$.

Table 5. The Postoperative Bishop Rating System (Excellent: 10-12, Good: 7-9, Poor: 0-6) in Both Groups Shows a Better Outcome with the Subcutaneous Technique, $p = 0.035$

Case	Subcutaneous Group	Submuscular Group
01	11	6
02	12	9
03	9	6
04	6	9
05	12	8
06	9	12
07	11	8
08	11	8
09	8	11
10	10	6
11	11	6
12	7	6
13	12	8

From contemplation of the above mentioned results, we could find that accepted outcome (good or excellent) was found in (12/13, 92%) of patients operated upon by subcutaneous transposition vs (8/13, 62%) in the submuscular one. On the other hand, poor outcome was the result in (5/13, 38%) of patients with submuscular transposition while in the subcutaneous transposition only one patient have developed poor outcome (1/13, 8%). This result gave an Odds ratio of 7.5, i.e. excellent or good results could be gained 7.5 times more in the subcutaneous approach than the submuscular one.

Table 6 shows that the subcutaneous technique was associated with excellent or good results 7.5 times more than the submuscular one.

Table 6. The Subcutaneous Transposition was Associated with Statistically Significant Better Outcome (Good or Excellent Results) than the Submuscular Transposition

Ulnar Nerve Transposition	No.	Postoperative Outcome				Odds Ratio
		Good or Excellent		Poor		
		No.	%	No.	%	
Subcutaneous	13	12	92%	1	8%	7.5
Submuscular	13	8	62%	5	38%	
Total	26	20	77%	6	23%	

DISCUSSION

There is currently little consensus about the appropriate surgical management of CubTS. The controversy comes from the diverging results of different surgical approaches reported in the literature. Macadam *et al.* [14] studied in a recent meta-analysis randomized controlled trials and observational studies comparing simple decompression of the ulnar nerve to anterior transposition (subcutaneous or submuscular) and found no statistically significant difference but rather a trend toward an improved clinical outcome with nerve transposition compared to simple decompression. This finding has encouraged researchers to recommend the simple decompression as the CubTS surgical treatment of choice because it is less invasive [15, 16].

However, critics of this technique claim that without transposition, the traction and compression of the ulnar nerve will not be relieved [17]. The subcutaneous and submuscular transpositions of the ulnar nerve were first described by Curtis in 1898 [18] and Learmonth in 1942 [19] respectively. Since then these two methods have become standard techniques in treating CubTS [14,20-22]. In the present study we made a comparison between these two techniques.

The patients' mean age of this study (34 years) and the male predominance (M:F 3.3:1) was comparable to the findings of others [3, 23]. This is probably due to the type of employment these patients have where repeated forcible elbow movements are encountered.

Regarding the presented clinical manifestations, we found that 100% of our patients showed affection of the sensory part of ulnar nerve function (intermittent paresthesia, positive Tinel's and elbow flexion tests). This may be due to the fact that the sensory function is jeopardized earlier and more extensively than the motor function. Furthermore, the increment of symptoms severity upon elbow flexion (positive elbow flexion test) may be attributed to the resultant narrowing with eventual decrease in the volume of the cubital tunnel causing increase in cubital tunnel pressure and increase the ulnar nerve intraneural pressure thus increasing the severity of symptoms [4]. The association of CubTS with elbow deformity (mainly valgus) and previous blunt trauma to the elbow was also mentioned by Solomon *et al.* [23] and Jobe *et al.* [10] who stated that valgus deformity and previous blunt trauma to the elbow may give rise to traction and scar formation respectively resulting in narrowing of the cubital canal.

One limitation of the present study is the relatively small sample size included. That is the reason why we chose to stratify our patients instead of randomizing them. Kernan *et al.* [24] stated that stratification has advantageous effects in small trials in which treatment outcome may be affected by known clinical factors and in trials which are designed to show the equivalence of two therapies.

Regarding the differences between the two techniques, we found that the subcutaneous approach, as compared to the submuscular approach, necessitated shorter incision (12-14cm vs 15-20 cm), easier surgical technique and haemostatic measures, and eventually, less mean operative time (≤ 30 minutes vs ≥ 45 minutes), less postoperative pain and earlier mobilization. These results agree with those of Black *et al.* [25] who also stated that subcutaneous ulnar

nerve transposition is an easier technique than the submuscular one with less haemostatic measures and eventually less operative time.

Subcutaneous ulnar nerve transposition demonstrated less postoperative pain and therefore earlier mobilization. This is in accordance with Artico *et al.* [26] and Tada *et al.* [27] who also reported less postoperative pain with earlier mobilization in subcutaneous ulnar nerve transposition. Postoperative wound infection was encountered only in the submuscular ulnar nerve transposition and this is in agreement with that of Bartels *et al.* [28] who also conducted a higher infection rate among those with submuscular ulnar nerve transposition. The submuscular procedure demanded more dissection measures to provide a soft vascularized muscle bed for the nerve, with more postoperative tissue oedema and so more vulnerability for wound infection. However, the sample size of the present study is relatively small and the incidence of infection rate encountered in the submuscular group (7%) may be non-conclusive.

The postoperative follow up and outcome of the two studied surgical techniques as determined by the Bishop scoring system (Table 4) showed superior results in the subcutaneous transposition group compared to the submuscular transposition group. These results agree with those of Köse *et al.* [22], Osterman *et al.* [29] and Asamoto *et al.* [30] who also concluded that subcutaneous ulnar nerve transposition is an excellent choice for the treatment of the cubital tunnel syndrome.

CONCLUSION

This feasibility study showed that the subcutaneous ulnar nerve transposition in the treatment of moderate CuTS, as compared to the submuscular approach, is an easier surgical technique with less operative time and postoperative pain, earlier postoperative mobilization and better postoperative outcome. However, the sample size included is limited and a properly performed randomized controlled trial with sufficient power estimation and follow-up period is need to evaluate the results of these two surgical techniques further.

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