Subcutaneous versus submuscular ulnar nerve transposition in cubital tunnel syndrome

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Received 12 December 2018
Accepted 27 December 2018

The Egyptian Orthopaedic Journal 2018, 53:292–297

Introduction

There are different surgical procedures for treatment of cubital tunnel syndrome (CubTS), which can be divided into two types, decompression and transposition procedures. Decompressive procedures include simple decompression with or without medial epicondylectomy without mobilizing the nerve. The transposition procedures mobilize the nerve anteriorly for more protection by subcutaneous, intramuscular, and submuscular methods, depending on the position in which the ulnar nerve is placed.

Patients and methods

A total of 24 patients with moderate CubTS (according to Dellon's grading system) between March 2011 and April 2013 were classified according to age and sex into anterior subcutaneous transposition and anterior submuscular transposition groups. The two groups were prospectively followed up for 2 weeks, 6 months, and 12 months postoperatively, and outcome was assessed using the Bishop rating system.

Results

A total of 24 patients with moderate CubTS were used in this study to compare the operative technique (incision length and 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. Final results present 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

Subcutaneous ulnar nerve transposition in the treatment of CubTS, as compared with the submuscular approach, is an easier surgical technique with less operative time and postoperative pain, earlier postoperative mobilization, and better postoperative outcome.

Keywords:
cubital tunnel, submuscular transposition, subcutaneous, ulnar nerve

Egypt Orthop J 53:292–297

1110-1148

Introduction

Cubital tunnel syndrome (CubTS) is the second most common peripheral nerve compression syndrome. CubTS is often referred to as sulcus-ulnaris syndrome (retrocondylar groove syndrome), which is anatomically incorrect, as the site of compression comprises not only the retrocondylar groove but the cubital tunnel, which consists of three parts: the retrocondylar groove partially covered by the cubital tunnel retinaculum (ligament arcuatum or Osborne ligament, the humeroulnar arcade, and the deep flexor/pronator aponeurosis). CubTS can be differentiated into a primary form, including anterior subluxation of the ulnar nerve with compression secondary to the presence of an anconeus epitrochlearis muscle and a secondary form caused by deformation or other processes of the elbow joint [1].

The clinical diagnosis is usually confirmed by nerve conduction studies. Ultrasound and MRI have become useful diagnostic tools by showing morphological changes in the nerve within the cubital tunnel. A differential diagnosis is essential in atypical cases and should include such conditions as C8 radiculopathy, Pancoast tumor, and pressure palsy [1]. Ulnar nerve compression at the elbow region, which is named CubTS, is the second most common compressive neuropathy of the upper limb after carpal tunnel syndrome [2]. The surgical management is broadly divided into three types of procedures [3]: simple decompression [4,5] medial epicondylectomy [6,7], and anterior transposition of the ulnar nerve. Moreover, variations of anterior transposition of the ulnar nerve have been proposed; these include subcutaneous [8–10], submuscular [11–13], intramuscular [14–16], and subfascial methods [3,17]. A subcutaneous transposition is a simple and reliable procedure that facilitates an early postoperative mobilization, but it is more vulnerable to trauma and hypersensitivity. A submuscular or intramuscular transposition is well protected as it lies deeply under a substantial amount of soft tissue with the disadvantages of prolonged postoperative elbow immobilization and potential subsequent contracture.

Patients and methods

Between March 2011 and April 2013, 24 patients with CubTS were treated at Zagazig University Hospital with anterior subcutaneous transposition (ASCT) and anterior submuscular transposition (ASMT), and were compared regarding the incision, operative time, and the postoperative care, including postoperative pain and complications. All patients operated after consent and under ethical comitte of zagazig university IRP. The outcome of the two surgical modalities in treating moderate CubTS was assessed according to Dellon Cubital tunnel syndrome grading system. The patients were stratified according to age and sex of these two surgical techniques. Exclusion criteria included deformity or distortion of the cubital tunnel owing to previous trauma to the elbow and recurrent CubTS after previous surgery. The two groups were prospectively followed up for 2 weeks, 6 months, and 12 months postoperatively. Operation outcome was assessed using the Bishop rating system. Clinical assessment of patients included analysis of symptom duration and severity. Clinical 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 paresthesia and abnormal vibratory perception using a tuning fork applied at the head of the fifth 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, and grade V: normal power). Tinel's and elbow flexion tests were performed. To exclude other diagnoses, plain radiography of the cervical spine and chest was done in all patients. The diagnosis was confirmed by electromyography where conduction velocity less than 50 m/s was considered as a positive finding. These patients were classified according to age (2-year margin) and sex into the subcutaneous group (n=12, male : female=8 : 4, mean age 34 years) and the submuscular group (n=12, male : female=7 : 5, mean age 36 years). In the subcutaneous group, the ulnar nerve was placed below the subcutaneous fat of the arm and forearm, whereas 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.

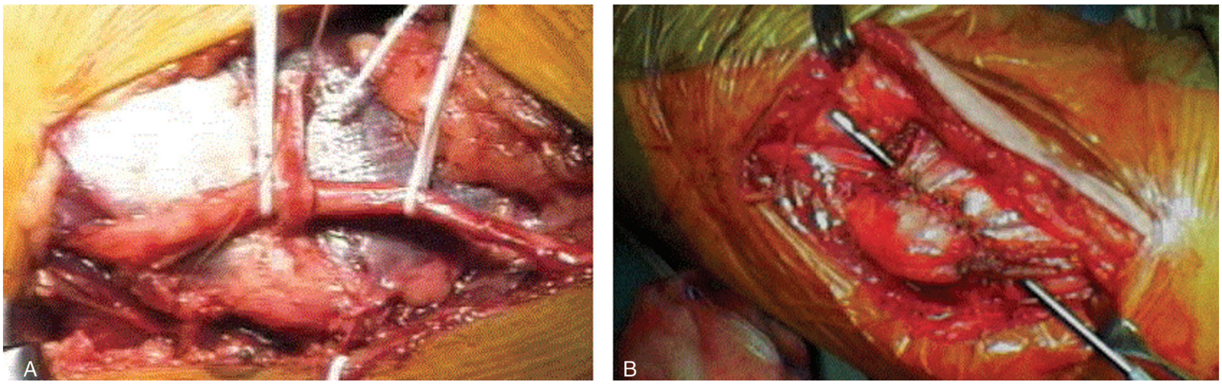
Surgical technique

In ASCT technique, the subcutaneous tissues were dissected toward the medial epicondyle anteriorly to create a subcutaneous bed where the ulnar nerve was transferred. After transposing the ulnar nerve, it is kept underlying the muscle fascia, which was sutured from below to the dermis using nonabsorbable 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 submuscular transposition technique, Z-lengthening of the flexor-pronator mass was done. Without a tourniquet for blood control, a longitudinal incision posterior to the medial epicondyle was performed. The identification of the medial cutaneous nerve was done. The ulnar nerve was identified and exposed up to the medial intramuscular 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. 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. Antibiotic therapy was given for 1–3 days and a splint was used postoperatively for 15 days (Fig. 1).

Postoperative follow-up

Visits were carried out prospectively at the outpatient clinic at 2 weeks, 6 months and 12 months. The primary outcomes of the surgical techniques

Figure 1



(a) Anterior subcutaneous ulnar nerve transposition and (b) anterior submuscular ulnar nerve transposition.

Table 1 The outcome of the operations was assessed 6–12 months postoperatively using the Bishop rating system [18,19]

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

included incision length, operative time, postoperative pain, and complications, whereas the secondary outcome was assessed 12 months postoperatively using the using the Bishop Rating System [18,19], where excellent: 10–12 points, good: 7–9 points, and poor: 0–6 points The postoperative pain was evaluated at the 2-week follow-up visit according to the following pain grading system: grade I (mild) pain, which can be easily ignored; grade II (moderate) pain, which cannot be ignored and interferes with function; grade III (severe) pain, which is present most of the time and

Table 2 The age distribution of the included patients

Age (years)	*n* (%)	χ^2	*P* value
<20	3 (12.6)		
20–29	0 (8.3)		
30–39	12 (50)	23.71	<0.001**
40–49	5 (20)		
≥50	2 (8.3)		
Total	24 (100)		

Table 3 The percentage of the presented clinical manifestations in both groups

Symptoms and signs	*n* (%)	χ^2	*P* value
Intermittent paresthesia	24 (100)		
Decreased vibratory perception	19 (79)	18.42	0.001*
Grip weakness	18 (75)		
Positive Tinel's sign	24 (100)		
Positive elbow flexion test	24 (100)		
Total	24 (100)		

demands constant attention; and grade IV (excruciating), totally incapacitating pain (Table 1).

Statistical analysis

Statistical analysis was done using obtaind data and were checked, entered, and analyzed using SPSS version 19 (SPSS Inc., Chicago, Illinois, USA) in Windows 7 for data processing and statistic. The data included age distribution, percentage of the presented clinical manifestations in both group, and the postoperative Bishop Rating System (excellent: 10–12, good: 7–9, poor: 0–6) in both groups. Total results were better with subcutaneous transfer than submuscular technique (Tables 2–6 and Fig. 2).

Results

Of the 24 patients treated in the study, 12 patients received ASCT and 12 patients received ASMT for CubTS. Overall, 62.5% were male and 37.5% were female. There were eight males in ASCT compared with seven males in ASMT group. More than 50% of the patients were at the age of 30–39 years (Table 2). The clinical manifestations of our patients are summarized in Tables 3 and 4. Elbow deformity (mainly valgus) was found in six (25%) patients whereas no obvious cause to CubTS (idiopathic) was found in 15 (62.5%) patients. History of previous blunt trauma to the elbow was reported by three (12.5%) patients. The results of Bishop rating system (Tables 5 and 6) show that the outcome in the subcutaneous group was excellent in 58.3% (n=7), good in 33.3% (n=4), and poor in 8.3% (n=1), whereas the outcome in the submuscular group was excellent in 25% (n=3), good in 50% (n=6), and poor in 25% (n=3). From the aforementioned results, we could find that acceptable outcome (good or excellent) was found in 11 (91.6%) of 12 patients operated upon by subcutaneous transposition, whereas nine (75%) of 12 patients in the submuscular one. On the contrary, poor outcome was the result in three (25%) of 12 patients with submuscular transposition, whereas in the subcutaneous transposition, only one (8.3%) patient

Table 4 The percentage of the presented clinical manifestations in both groups

Variables	Subcutaneous	Submuscular
Length of incision	12–14 cm	15–20 cm
Mean operative time	≥30 min	≥45 min
Postoperative pain	Mild	Moderate
Postoperative wound infection (n=12)	0 (0)	1 (8.3)

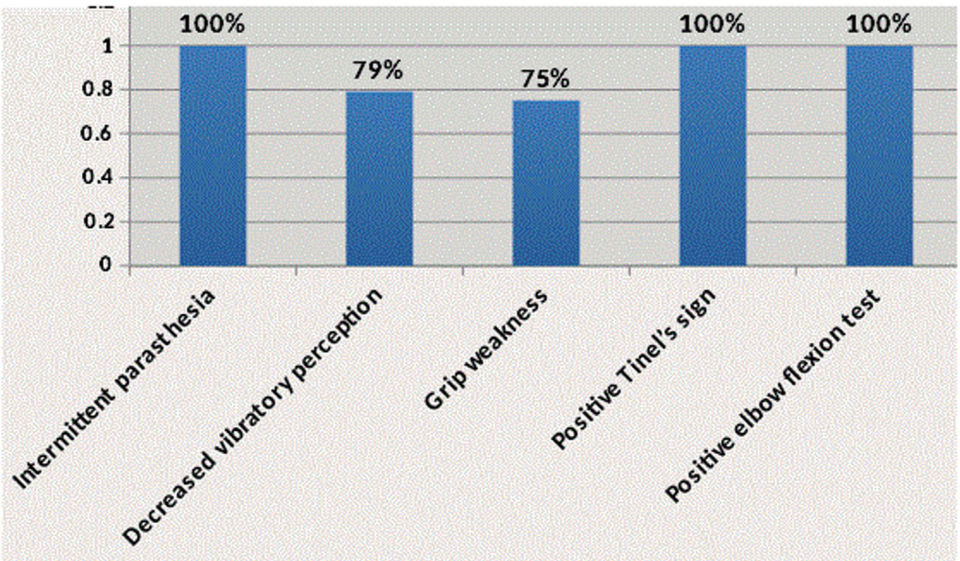
Table 5 The postoperative Bishop rating system (excellent: 10–12, good: 7–9, and poor: 0–6) in both groups shows a better outcome with the subcutaneous technique

Case no.	Subcutaneous group	Submuscular group
1	7	8
2	11	9
3	10	11
4	8	6
5	11	8
6	10	7
7	9	11
8	12	9
9	6	6
10	9	9
11	12	6
12	10	11

Table 6 Total results with better subcutaneous transfer than submuscular technique

Ulnar nerve transposition	N	Postoperative outcome [n (%)]		χ^2	P value
		Excellent to good	Poor		
Subcutaneous	12	11 (91.6)	1 (8.3)	1.2	0.273
Submuscular	12	9 (75)	3 (25)		
Total	24	20 (83.3)	4 (16.6)		

Figure 2



Presented clinical manifestation in both groups.

developed poor outcome. This result gave odds ratio [PG1/(1-PG2)=94.6/(1–75)] of 1.2, that is, excellent or good results could be gained 1.2 times more in the subcutaneous approach than the submuscular one.

Discussion

The subcutaneous and submuscular transpositions of the ulnar nerve were first described by Curtis in 1898 [20] and Learmonth in 1942 [21]. These two methods have become standard techniques in treating CubTS [22–25] In the present study, we made a comparison between these two techniques. A meta-analysis of randomized controlled trials by Macadam *et al.* [22] compared simple decompression of the ulnar nerve with anterior transposition (subcutaneous or submuscular) and found no statistically significant difference but rather a trend toward an improved clinical outcome with nerve transposition compared with simple decompression. The study recommends the simple decompression as the CubTS surgical treatment of choice because it is less invasive [26,27]. Risks of simple decompression of the ulnar nerve without transposition, the traction, and compression of the ulnar nerve will not be relieved [28]. The patients' mean age in this study was 34 years and there was a male predominance (male : female 1.6 : 1). Regarding the presented clinical manifestations, we found that 100% of our patients showed affection of the sensory part of ulnar nerve function (intermittent paresthesia and positive Tinel's and elbow flexion tests) as the sensory function is earlier and more extensively affected than the motor function. The increment of symptoms severity upon elbow flexion (positive elbow flexion test) is related to the resultant narrowing with eventual decrease in the volume of the cubital tunnel causing increase in cubital tunnel pressure and increase in the ulnar nerve intraneural pressure, thus increasing the severity of symptoms [29]. The association of CubTS with elbow deformity (mainly valgus) and previous blunt trauma to the elbow was also mentioned by Solomon *et al.* [30] and Jobe and Martinez [31]. Valgus elbow deformity was present in six (25%) patients, whereas no obvious cause to CubTS (idiopathic) was found in 15 (62.5%) patients. History of previous blunt trauma to the elbow was reported by three (12.5%) patients of in this study. 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. Regarding the differences between the two techniques, we found that the subcutaneous approach, as compared with the submuscular approach, necessitated shorter incision (12–14 vs. 15–20 cm), was an easier surgical technique, maintained hemostatic measures, required less mean operative time (≤30 vs. ≥45 min), and had less postoperative pain and earlier mobilization. These results agree with those of Black *et al.* [32], who also stated that subcutaneous ulnar nerve transposition is an easier technique than the submuscular one with less hemostatic measures and eventually less operative time. Subcutaneous ulnar nerve transposition has less postoperative pain and earlier mobilization. Artico *et al.* [33] and Tada *et al.* [34] 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 in this study, which is comparable with that of Bartels and Grotenhuis [35], who also obtained 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 edema and so more vulnerability for wound infection. In this study, the postoperative follow-up and outcome of the two studied surgical techniques as determined by the Bishop scoring system showed superior results in the subcutaneous transposition group compared WITH the submuscular transposition group. These results agree with those of Köse *et al.* [25], Osterman and Davis [36], and Asamoto *et al.* [37], who also concluded that subcutaneous ulnar nerve transposition is an excellent choice for the treatment of the cubital tunnel.

Conclusion

The results of this study showed that the subcutaneous ulnar nerve transposition in the treatment of moderate CuTS, as compared with the submuscular approach, is an easier surgical technique with less operative time and postoperative pain, earlier postoperative mobilization, and better postoperative outcome.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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