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Original Article

Median to Ulnar Nerve Transfer in Severe Cubital Tunnel Syndrome

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BACKGROUND: Cubital tunnel syndrome is a common entrapment neuropathy that affects about 30 per 100,000 population and follows carpal tunnel syndrome in prevalence. Its incidence rises with advancing age with more males affected than females. Patients harboring cubital tunnel syndrome suffer from sensory disturbance involving the medial side of the ring finger and the little finger. Exacerbation of symptoms is noted at night because during sleeping the elbow is flexed. In severe entrapment, patients may suffer from weakness in the small muscles of the hand. Patients with severe degree of compression usually do not recover completely following simple decompression at the elbow.

OBJECTIVE: The aim of the study is to assess the results of end to side supercharge transfer of the pronator quadratus branch of the anterior interosseous nerve to the motor branch of the ulnar nerve, in patients suffering from severe cubital tunnel syndrome.

PATIENTS AND METHODS: This study included 15 cases with severe cubital tunnel syndrome where the pronator quadratus branch of the anterior interosseous nerve was transferred in an end to side fashion to the motor branch of the ulnar nerve as an adjunctive to transposition of the ulnar nerve at the elbow and release at Guyon's canal. The severity of the entrapment was classified according to the McGowan Grading system. Motor power was recorded according to the Medical Research Council (MRC) grading of motor power.

RESULTS: Over an 18 months follow up period, we had improved motor function ≥ 3 on MRC in 13 out of 15 patients (85%) and all patients had some subjective sensory improvement. Muscle atrophy improved in 80% and claw hand deformity improved in 67% of the patients.

CONCLUSION: In conclusion, the pronator quadratus branch of the anterior interosseous nerve reverse end-to-side transfer to the motor branch of the ulnar nerve, together with ulnar nerve transposition at the elbow and surgical decompression at the wrist, helps with enhancing the recovery of hand muscles motor functions and muscle atrophy in patients with severe ulnar entrapment at the elbow.

KEYWORDS: Clawing, Cubital tunnel, Nerve transfer.

INTRODUCTION

Cubital tunnel syndrome is the second most common entrapment neuropathy following carpal tunnel syndrome and it is slightly more common in the male population unlike the carpal tunnel syndrome.[1]

Ulnar nerve compression at the elbow has many causes including habitual elbow flexion, positional factors, anomalous anatomy (e.g. anconeus epitrochlearis) or previous surgery with resulting adhesions….etc. Studies have found increased pressure inside the nerve and diminished volume within the compartment of the cubital tunnel with elbow flexion.[2]

Symptoms include motor and sensory manifestations which usually start with parasthesia in the ulnar nerve distribution and can mount up to muscle weakness and atrophy if neglected. Patients might suffer from claw hand deformity due to weakness of the intrinsic hand muscles with unopposed normal function of the flexor digitorum profundus.[3]

Cubital tunnel syndrome is classified according to the Mcgowan classification into 3 grades. Grade 1 is purely subjective sensory symptoms and mild hyposthesia, grade 2 is sensory loss and weakness of intrinsic hand muscles with or without slight wasting, whereas grade 3 is considered when severe sensorimotor deficit is found with evident atrophy.[4] Severe cubital tunnel syndrome presents with sensory loss and loss of intrinsic hand muscle function that affects the fine motor skills and affects the overall hand function.[5]

In our study, we aimed to assess our experience in management of cases of severe cubital tunnel syndrome with decompression at the elbow and the wrist together with median to ulnar nerve transfer.

PATIENTS AND METHODS

This prospective study was conducted in Alexandria Main University Hospital and affiliated hospitals after approval of the ethical committee and after consenting the patients for being enrolled in the study. We operated upon 15 patients who presented with severe cubital tunnel

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syndrome with weakness of intrinsic muscles of the hand and partial clawing, with entrapment at the level of the elbow and no signs of entrapment at Guyon's canal. We operated on 12 males and 3 females with a mean age of 33 years. The dominant limb was the affected limb in 10 cases. Patients with systemic diseases affecting the peripheral nerve function e.g., diabetes mellitus were excluded. Two of our patients were smokers **(Table 1)**. Three patients had previous simple decompression at the elbow with no improvement and progressive deterioration.

The severity of the entrapment was classified according to the McGowan Grading system. Grade I patients have mild lesions with parasthesia in the ulnar nerve distribution and a feeling of clumsiness in the affected hand with no wasting or weakness of the intrinsic muscles, whereas patients with intermediate lesion with weak intrinsic muscles and muscle atrophy are considered as grade II. Finally, grade III patients have severe lesions with paralysis of the intrinsics and profound hand weakness.[4] All our patients had McGowan grade III ulnar neuropathy with complete sensory loss in the ulnar nerve distribution, with evidence of intrinsic hand muscle wasting and atrophy of the interossei with hollowing of the first web space **(Fig. 1)**. Evidence of partial clawing deformity was found in 9 patients on preoperative examination observed one month before surgery.

Motor power was recorded according to the Medical Research Council (MRC) grading of motor power.[5] Patients were considered grade zero with total paralysis, grade 1 with only a trace or flicker of muscle contraction seen or felt, grade 2 when muscle movement was possible with gravity eliminated, grade 3 when muscle movement was possible against gravity, grade 4 where muscle strength was reduced but movement against resistance was possible and finally grade 5 with normal muscle strength. All patients had motor power <3 on MRC grading where 10 patients were grade 1, 3 patients were grade 2 and 2 patients were grade zero.

All patients underwent nerve conduction studies and electromyography (EMG) testing before surgery confirming the diagnosis. All patients had absent sensory response to the small finger with diminished compound muscle action potential (CMAP) to the intrinsic ulnar innervated hand muscles to less than 30% of normal values. Eight patients underwent ultrasonography which showed thickening of the nerve at the elbow, but no signs of hypermobility were noticed. All patients had intact median nerve (donor) and this was confirmed by electrophysiological studies. The interval between the development of symptoms and surgery ranged between 6 months and 12 months.

We adopted a standard technique of anterior transposition of the nerve in the submuscular plane at the elbow with decompression at Guyon's canal distally. Three patients had previous surgery for simple decompression at the elbow with no improvement. We did our transfer where the pronator quadratus branch of the anterior interosseous nerve (AIN) was used as a donor to the deep motor ulnar nerve as a supercharge transfer in all 15 patients (end to side transfer).

All patients were operated upon under general anesthesia in supine position and the limb fully draped for changing position intraoperatively, without use of inhalational anesthesia for intraoperative stimulation. We used tourniquet in 2 cases. Decompression of the ulnar nerve at the elbow was done using the standard technique with release of the Struthers arcade and incising the intermuscular septum and decompression between the 2 heads of the flexor carpi ulnaris (osborne ligament). Anterior transposition of the ulnar nerve was done and was repositioned in the submuscular plane after creating the space and fixed by the pronator fascia **(Fig. 2)**. At the wrist, decompression of the ulnar nerve at Guyon's canal till the bifurcation of the sensory and motor branches was accomplished **(Fig. 3)**.

The motor division of the ulnar nerve was traced proximally and internal neurolysis of the ulnar nerve was done under microscopic magnification, where the motor branch was found between the two sensory fascicles approximately 10 cm proximal to the wrist crease and confirmed using nerve stimulator. Next, the AIN of the median nerve was identified and its distal branch to the pronator quadratus entering the proximal edge of muscle was identified after retracting the flexor muscle group laterally, where it was divided as distal as possible. The transfer was completed and the AIN was joined to the motor branch of ulnar nerve in an end-to-side fashion using interrupted sutures of 8-0 prolene and applying fibrin glue (supercharge reverse end to side innervation) **(Figs. 4, 5)**. This was followed by short period of immobilization postoperatively (10 days – 2 weeks). Patients underwent physiotherapy sessions and rehabilitation for 6 months postoperatively.

Fig 1: Patient having atrophy of the hand intrinsic muscles.

Fig 2: Incision for decompression and transposition of the ulnar nerve at the elbow.

Fig 3: Incision for the AIN to ulnar nerve transfer and decompression at Guyon's canal.

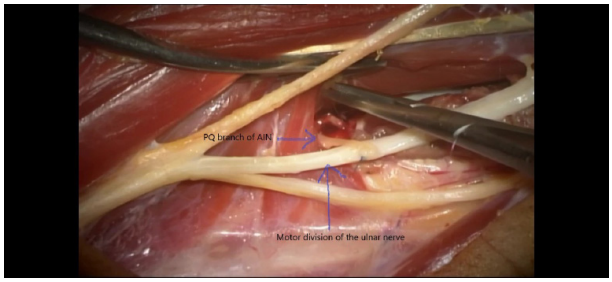

Fig 4: Intraoperative image showing AIN pronator branch and motor ulnar nerve division for preparation of nerve transfer (under tourniquet).

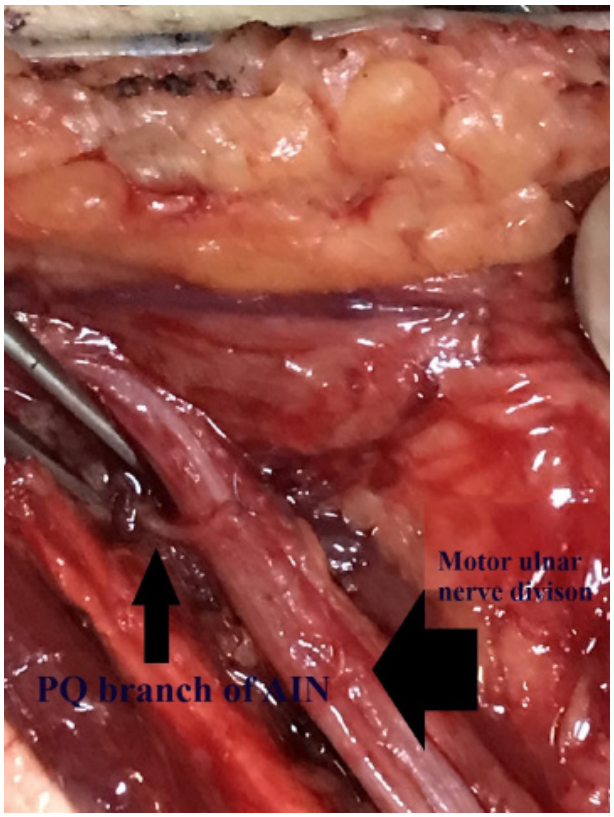

Fig 5: Intraoperative image showing AIN pronator branch and motor ulnar nerve division for preparation of nerve transfer (under tourniquet).

RESULTS

All patients were followed postoperatively for 18 months. Nine patients showed improvement in intrinsic hand function achieving grade 4 on MRC scale, 2 patients were almost back to normal (grade 5), and 2 patients achieved grade 3 motor power. Two patients who had grade zero MRC score preoperatively showed no motor improvement, however, they reported subjective sensory improvement and better sense of dexterity. Regarding the muscle atrophy, 12 patients showed progressive improvement over the follow up period (80%) and 6 patients out of the 9 patients with clawing improved (66.7%) (Table 1). All patients started to experience some improvement of dexterity 3 weeks postoperatively, though motor improvement was not noticed before 3 months in 4 patients (30%) and 9 patients improved over 1 year period (70%).

Overall, patients who had surgery early after the development of symptoms had more rapid improvement of their symptoms and tended to achieve better functional outcome.

We had 2 patients who suffered persistent elbow pain postoperatively. One patient had transient causalgia like symptoms postoperatively which lasted for 2 weeks. No deficit in pronation was noted in any of our patients.

Table 1: Clinical findings of 60 patiens included in the study

Variable	
Number	**15 patients**
Mean age	33 yrs
Sex (Male: Female)	12:3
Dominant limb	10
Smoking	2
Preoperative MRC score	Grade zero: 2 Grade 1: 10 Grade 2: 3
Postoperative MRC score	Grade zero: 2 Grade 3: 2 Grade 4: 9 Grade 5: 2
Atrophy and clawing assessment	Muscle atrophy improvement 12/15 (80%) Clawing deformity improvement 6/9 (67%)

DISCUSSION

Management of patients with severe cubital tunnel syndrome with atrophy and clawing is variable with unpredictable results, especially with long duration of atrophy prior to intervention and need for regeneration from the site of the compression at the elbow to the hand muscles, which might result in denervation of the Schwann cells and decrease the capacity for regeneration.[6,7]

Mowlavi et al. reported improvement in mild and moderate cases with standard basic surgical techniques including epicondylectomy, decompression and transposition, however no good outcomes were found in severe cases.[8]

In our study, 13 out of 15 patients (85%) showed improvement of motor power to ≥ 3 according to MRC grading, whereas none of the patients had more than grade 2 preoperatively. Nine patients achieved grade 4 (60%) and 2 patients achieved grade 5 (13%). Eighty percent of our patients showed improvement of the hand muscles atrophy and 67% of patients showed improvement of the claw hand deformity. All patients even those who did not show motor improvement noticed sensory improvement and improvement of hand dexterity. Thirty percent of our patients had motor improvement within 3 months of surgery.

In a study by Doherty et al., they reported that 73% of their patients achieved ≥3 on MRC grading, where 47% achieved grade 4 and 7% achieved grade 5, in a cohort of 30 patients. Partial or complete resolution of hand muscle

atrophy was noticed in 77% of their patients whereas 80% showed improvement of the clawing in spite of the presence of atrophy and clawing for more than 1 year preoperatively.[9] They also stated that CMAP improved on the postoperative electrical study which is one of the weaknesses of our study which lacks postoperative electrical studies in 12 patients out of 15.[9]

Dengler et al. reported improvement in 39 out of the 42 patients (93%) they have operated upon using AIN to ulnar nerve transfer. They added ulnar nerve transposition in 34 patients and Guyon's canal release in 40 patients in their series. They stated that the age was the only significant factor for poor outcome. They mentioned that 21 patients (54%) improved within 3 months of surgery and 46% improved over 15 months period, and the duration of symptoms was shorter in the patients who improved earlier.[10]

Mackinnon et al. presented their algorithm where nerve transfer is indicated together with ulnar nerve transposition at the elbow and release at Guyon's canal in cases with intrinsic hand muscle weakness, diminished CMAP amplitude at the wrist and EMG showing fibrillation potentials and positive sharp waves.[11]

CONCLUSION

We concluded that the pronator quadratus branch of the anterior interosseous nerve reverse end-to-side transfer to the motor branch of the ulnar nerve, together with transposition of the ulnar nerve at the elbow and decompression at the Guyon's canal, helps with enhancing recovery of intrinsic hand muscle strength in patients with severe ulnar compression at the elbow. It should be recommended as a standard technique especially in patients suffering from atrophy and wasting of the hand muscles and clawing deformity, even though not all patients attained full recovery, as any recovery of the intrinsic motor function is worthy. However, it is associated with longer duration of surgery and it is more technically demanding, in contrary to simple decompression.

List of Abbreviations

AIN: Anterior interosseous nerve.
CMAP: Compound muscle action potential.
EMG: Electromyography.
MRC: Medical research council.

Disclosure

The authors report no conflict of interest in the materials or methods used in this study or the findings specified in this paper.

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