Recovery of ulnar innervated intrinsic muscles following anterior transposition of the ulnar nerve

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A chart review of 26 patients who underwent anterior transmuscular transposition of the ulnar nerve and had a preoperative nerve conduction velocity less than 40 m/s across the elbow was completed. Patients with intrinsic muscle wasting before surgery were contacted for follow-up. One patient returned for follow-up evaluation. Preoperatively, this patient had complete numbness in the small and ring fingers, and severe intrinsic muscle wasting; left hand pinch and grip strengths were 4.5 kg and 34 kg, respectively. At the final evaluation, 67 months following surgery, left hand pinch and grip strengths were 10.9 kg and 54.5 kg, respectively. The patient had good intrinsic muscle reinnervation; his intrinsic hand muscle mass appeared to be equal to the uninvolved hand and there was no evidence of a Wartenberg's sign. This long term patient follow-up suggests that ulnar nerve transposition can facilitate the return of intrinsic muscle mass and function among patients with cubital tunnel syndrome.

Key Words: *Anterior transposition; Ulnar nerve*

Rétablissement des muscles intrinsèques innervés par le nerf cubital après une antéroposition du nerf

RÉSUMÉ : Nous avons passé en revue les dossiers de 26 patients ayant subi une antéroposition intramusculaire du nerf cubital dont la vitesse de conduction dans le coude était inférieure à 40 m/s avant l'opération et nous avons communiqué avec ceux qui présentaient une atrophie des muscles intrinsèques avant l'intervention pour leur demander de participer à une évaluation de suivi. Un seul patient s'est présenté. Avant l'opération, ce patient avait l'auriculaire et l'annulaire complètement engourdis et présentait une atrophie grave des muscles intrinsèques; la force de pincement et de préhension de la main gauche était de 4,5 et de 34 kg respectivement. À la dernière séance d'évaluation, soit 67 mois après l'opération, la force de pincement et de préhension de la main gauche était de 10,9 et 54,5 kg respectivement. Les muscles intrinsèques semblaient bien réinnervés : la masse des muscles intrinsèques de la main gauche paraissait égale à celle de la main droite, sans signe de Wartenberg. Le suivi à long terme du patient donne à penser que l'antéroposition du nerf cubital favorise le retour de la masse et de la fonction des muscles intrinsèques chez les patients atteints du syndrome du tunnel cubital.

Cubital tunnel syndrome is the second most common nerve compression syndrome of the upper extremity. Patient presentation ranges from occasional paresthesia to profound weakness and muscle atrophy. Longstanding chronic nerve compression of the ulnar nerve may cause degeneration of motor nerve fibres, leading to atrophy of the intrinsic muscles of the hand, and clawing of the fourth and fifth digits. Reinnervation of intrinsic muscles innervated by the ulnar nerve following a traumatic open injury to the ulnar nerve at the elbow is rarely anticipated because of the long distance from the injury site to the target muscles (1). However, with ulnar nerve compression at the cubital tunnel, it is possible to achieve reinnervation of ulnar innervated intrinsic muscles (1). A case study of a patient following ulnar nerve transposition for cubital tunnel syndrome with preoperative intrinsic muscle atrophy is presented.

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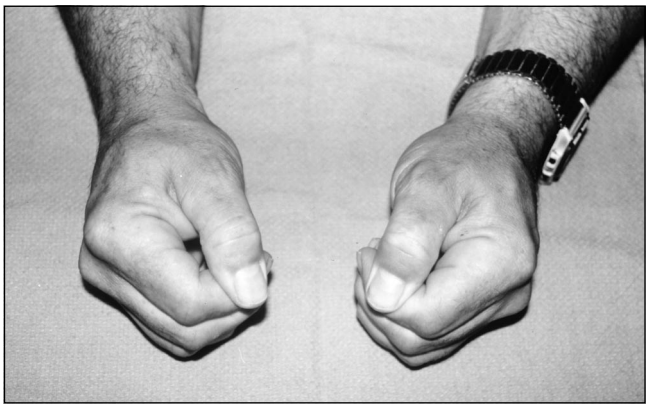

Figure 1) *Hands of a patient presenting with good muscle bulk in the first dorsal web space*

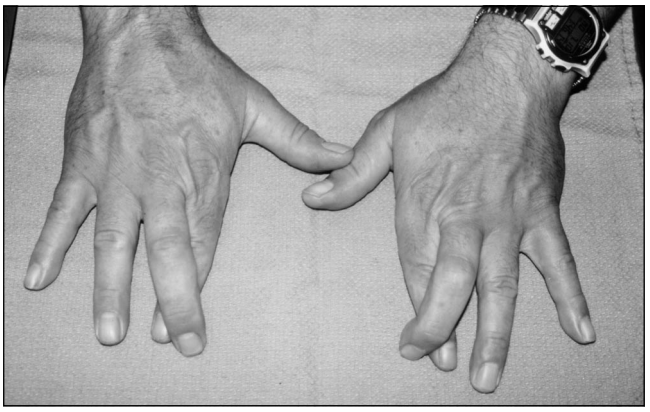

Figure 2) *Hands with good ulnar nerve intrinsic muscle reinnervation, demonstrated by the patient's ability to cross his fingers*

PATIENTS AND METHODS

Patient selection and procedure

A chart review of 26 patients who underwent surgical treatment for cubital tunnel syndrome with the preoperative nerve conduction studies less than 40 m/s across the elbow was completed. All surgeries were performed by one surgeon from Washington University School of Medicine, St Louis, Missouri by using anterior transmuscular transposition of the ulnar nerve with myofascial lengthening of the flexor pronator mass region (2). Patients who had undergone a secondary surgery for ulnar nerve compression were excluded. Data collected from charts consisted of preoperative nerve conduction studies, pre- and postoperative pinch and grip strengths, and the interval between surgery and the most recent follow-up.

Intrinsic muscle wasting before surgery was noted in six patients' charts (surgery was performed on eight arms), and these patients were contacted for follow-up. One patient returned for long term follow-up evaluation.

RESULTS

Case presentation

A 48-year-old man was successfully recruited for follow-up 67 months after anterior transmuscular transposition of the ulnar nerve. At the beginning of February 1994, the patient awoke one morning with complete numbness to his left small finger and the ulnar side of the ring finger, and a marked decrease in strength in the ulnar innervated muscles of his hand. He went to see a neurologist, and nerve conduction studies and electromyography were performed 10 days after the onset of symptoms. The nerve conduction studies indicated cubital tunnel syndrome with motor nerve conduction velocity across the elbow of 21 m/s and a normal upper arm velocity. The electromyography results showed evidence of acute and chronic denervation of the ulnar innervated intrinsic hand muscles. The patient had no medical history of diabetes or alcoholism, although he smoked up to two packs of cigarettes/-day. Clinically, his preoperative pinch strength was 4.5 kg and grip strength was 34 kg, and he had severe wasting of the ulnar innervated intrinsic muscles in the nondominant hand. The patient had positive Wartenberg's and Froment's signs on the left hand.

An anterior transmuscular ulnar nerve transposition was performed on the nondominant arm on April 8, 1994. At follow-up, 15 months after surgery, the patient's pinch and grip strengths were 8.2 kg and 31.8 kg, respectively. At the final evaluation for the present study, 67 months following surgery, the pinch and grip strengths of the left hand were 10.9 kg and 54.5 kg, respectively, compared with 13 kg and 56.8 kg, respectively on the right. The patient had good intrinsic muscle reinnervation because his intrinsic hand muscle mass appeared to be equal to that of the uninvolved hand, and there was no evidence of a Wartenberg's sign (Figures 1,2).

DISCUSSION

The surgical management of patients with intrinsic muscle wasting secondary to cubital tunnel syndrome is controversial. Some contend that once atrophy occurs, surgical efforts to relieve compression at the cubital tunnel will not result in the return of intrinsic muscle function. The present study reviewed intrinsic muscle atrophy in five hands before and after anterior transmuscular transposition of the ulnar nerve, with myofascial lengthening of the flexor pronator mass region. Improvement of intrinsic atrophy was noted in the charts of all five patients at follow-up. These results are consistent with several studies that reported improvement of intrinsic muscle mass after surgical relief of ulnar nerve compression at the cubital tunnel (3).

Many studies have evaluated outcomes following surgical treatment for ulnar nerve compression by using a variety of pre- and postoperative rating schemes (4-17). Dellon's (3) analysis of 50 papers published from 1898 to 1988 reported results from 1435 patients with cubital tunnel syndrome. Patients' symptoms were ranked as mild, moderate or severe, based on Dellon's classification. A severe ranking reflected motor function findings of measurable weakness in pinch and grip strengths, plus muscle atrophy. Of the 516 patients with symptoms that were rated as severe before treatment, 110 patients did not have atrophy after surgery.

Steiner et al (15) reported outcomes for 41 patients undergoing simple decompression. At presentation, 30 patients had muscle atrophy (11 cases were severe), and after surgery, 17 patients had persistent muscle wasting (three cases were severe). In a prospective, randomized trial (n=47) of medial epicondylectomy compared with ulnar nerve transposition by Geutjens et al (5), preoperatively, 21 patients had severe atrophy and 15 patients had moderate atrophy. After surgical treatment, only nine patients had severe atrophy and 14 patients had moderate atrophy. There was no significant difference in intrinsic muscle findings among the two treatment groups.

Asami et al (18) evaluated 41 patients following an ulnar nerve anterior transposition, with or without preservation of extrinsic vessels; preoperatively, 20 patients were graded as having McGowan grade III symptoms. After surgery, atrophy was present in three patients, persistent but improved in 11 patients and absent in 27 patients. Pasque and Rayan (12) reported outcomes after anterior submuscular transposition in 50 limbs. According to the authors' criteria, 27 patients had symptoms that were graded as poor, indicating severe atrophy and clawing before surgery. After surgery, no patients were graded as having poor symptoms (12). Tada et al (19) reported the outcomes for 46 patients after surgery by using the modified King's method. Patients were graded using a variation of the scoring system developed by Stuffer et al (16) that includes intrinsic muscle wasting. Before surgery, 28 patients were rated as having poor symptoms; following surgery, four patients were rated as having excellent symptoms, 11 received a good rating, 12 received a fair rating and one received a poor rating. Kaempffe and Farbach (6) reported findings for 27 patients who were treated with partial medial epicondylectomy. Four patients had intrinsic muscle atrophy before surgery, and the muscle wasting persisted after surgery (6).

The analysis by Bartels et al (20) of studies published from 1970 to 1997 consisted of 740 patients; 350 patients were rated as having McGowan grade III symptoms before treatment. Outcomes were classified according to the Alnot & Frajman scale. The scale rates outcomes as follows: an excellent outcome indicates the complete resolution of symptoms; a good outcome indicates muscle strength of grade 4 or 5 based on the Medical Research Council (MRC) grading system; fair indicates MRC grade of 3; and poor indicates no improvement. Bartels et al (20) did not make any specific comments about intrinsic muscle wasting. Among patients whose symptoms were rated as McGowan grade III before surgery, 102 patients achieved excellent results, 132 achieved good results, 62 achieved fair results and 54 achieved poor results.

Two studies by Nathan et al (9,10) reported results for simple decompression, assessing outcome by patients reporting decreased symptoms of numbness or tingling. A satisfactory result indicated a greater than 50% reduction in symptoms. A total of five patients with atrophy underwent simple decompression, and four of these patients achieved satisfactory results. Nouhan and Kleinert (11) reported results of transposition with Z-lengthening of the flexor-pronator mass for 33 patients by using the modified Bishop Rating System, which scores the severity of residual symptoms, improvement, work status, strength and sensibility. Twenty patients were graded as severe by using Dellon's classification; six of these patients achieved excellent results, 13 achieved good results and one achieved poor results.

The present study is supported by previous studies suggesting that patients with intrinsic muscle wasting secondary to cubital tunnel syndrome can recover muscle mass after surgical treatment. However, the wide variety of pre- and postoperative grading schemes make it difficult to compare outcomes following different operative procedures.

Improvement in intrinsic muscle atrophy following cubital tunnel surgery may reflect the underlying pathophysiology of nerve compression. Transection of the nerve trunk in a traumatic injury completely disrupts neural continuity, thus precluding reinnervation of the muscles after a long delay of neural input. In animal models, delaying repair for more than one month following nerve transection significantly impairs recovery of muscle mass (21). The distinction between incontinuity and transected lesions may explain the differences in prognosis associated with chronic nerve compression compared with traumatic injuries.

The results of this study have several limitations. In the 26 patient charts reviewed, the examining physician noted muscle wasting in the six study patients, but did not comment on intrinsic muscle mass in the remaining 20 patients. Similarly, follow-up examinations for only four of the eight arms that underwent surgery commented on intrinsic muscle mass. The present study's small sample size and variation in the follow-up interval limited statistical analysis. A larger patient sample can assess mean time to improved pinch strength, as well as whether variables, such as preoperative nerve conduction studies, duration of symptoms, mechanism of injury and patient age may affect postoperative outcome.

CONCLUSIONS

This long term patient follow-up study suggests that ulnar nerve transposition can facilitate return of ulnar nerve innervated intrinsic muscle mass and function in patients with cubital tunnel syndrome. Severe intrinsic atrophy should not be considered a contraindication to surgery for cubital tunnel syndrome.

REFERENCES

1. Kline DG, Hudson AR. Nerve Injuries – Operative Results for Major Nerve Injuries, Entrapment and Tumors. Philadelphia: WB Saunders, 1995.
2. Mackinnon SE. Submuscular transposition of the ulnar nerve at the elbow. In: Rengachary SS, Wilkins RH, eds. Neurosurgical Operative Atlas. Illinois: American Association of Neurological Surgeons, 1995:225-33.
3. Dellon AL. Review of treatment results for ulnar nerve entrapment at the elbow. J Hand Surg [Br] 1989;14(Suppl A):688-700.
4. Adelaar RS, Foster WC, McDowell C. Treatment of cubital tunnel syndrome. J Hand Surg [Br] 1984;9(Suppl A):90-5.
5. Geutjens GG, Langstaff RJ, Smith NJ, Jefferson D, Howell CJ,

Barton NJ. Medial epicondylectomy or ulnar nerve transposition for ulnar neuropathy at the elbow. J Bone Joint Surg [Br] 1996;78(Suppl B):777-9.
6. Kaempffe FA, Farbach J. A modified surgical procedure for cubital tunnel syndrome: Partial medial epicondylectomy. J Hand Surg [Br] 1998;23:492-9.
7. Kleinman WB, Bishop AT. Anterior intramuscular transposition of the ulnar nerve. J Hand Surg [Br] 1989;14:972-9.
8. Mackinnon SE, Dellon AL. Surgery of the Peripheral Nerve. New York: Thieme Medical Publishers, 1988.
9. Nathan PA, Myers LD, Keniston RC, Meadows KD. Simple decompression of the ulnar nerve: An alternative to anterior transposition. J Hand Surg [Br] 1992;17:251-4.
10. Nathan PA, Keniston RC, Meadows KD. Outcome study of ulnar nerve compression at the elbow treated with simple decompression and an early programme of physical therapy. J Hand Surg [Br] 1995;20(Suppl B):628-37.
11. Nouhan R, Kleinert JM. Ulnar nerve decompression by transposing the nerve and Z-lengthening the flexor pronator mass: clinical outcome. J Hand Surg [Br] 1997;22:127-31.
12. Pasque CB, Rayan GM. Anterior submuscular transposition of the ulnar nerve for cubital tunnel syndrome. J Hand Surg [Br] 1995;20:447-53.
13. Pribyl CR, Robinson B. Use of the medial intermuscular septum as a fascial sling during anterior transposition of the ulnar nerve. J Hand Surg [Br] 1998;23:500-4.
14. Seradge H, Owen W. Cubital tunnel release with medial epicondylectomy factors influencing the outcome. J Hand Surg [Br] 1998;23:483-91.
15. Steiner HH, von Haken MS, Steiner-Milz HG. Entrapment neuropathy at the cubital tunnel: Simple decompression is the method of choice. Acta Neurochir 1996;138:308-13.
16. Stuffer M, Jungwirth W, Hussl H, Schmutzhardt E. Subcutaneous or submuscular anterior transposition of the ulnar nerve. J Hand Surg [Br] 1991;17:248-50.
17. Tetro A, Pichora DR. Cubital tunnel syndrome and the painful upper extremity. Hand Clin 1996;12:665-77.
18. Asami A, Morisawa K, Tsuruta T. Functional outcome of anterior transposition of the vascularized ulnar nerve for cubital tunnel syndrome. J Hand Surg [Br] 1998;23:613-6.
19. Tada H, Hirayama T, Katsuki M, Habaguchi T. Long term results using a modified King's method for cubital tunnel syndrome. Clin Orthop 1997;336:107-10.
20. Bartels RHMA, Menovsky T, Van Overbeeke JJ, Verhagen WIM. Surgical management of ulnar nerve compression at the elbow: an analysis of the literature. J Neurosurg 1998;89:722-7.
21. Kobayashi J, Mackinnon SE, Watanabe O, et al. The effect of duration of muscle denervation on functional recovery in the rat model. Muscle Nerve 1997;20:858-66.