The Effect of Vascular Pedicle Preservation on Blood Flow and Clinical Outcome Following Ulnar Nerve Transposition

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Purpose To evaluate the efficacy of a technique to preserve the extrinsic vascular supply to the ulnar nerve after transposition and its effect on blood flow and clinical outcome.

Methods We included 36 patients with cubital tunnel syndrome. The patients were randomly selected to undergo vascular pedicles−sparing surgery for anterior ulnar nerve transposition (VP group) or nerve transposition and artery ligation (non-VP group). Blood flow to the ulnar nerve was estimated intraoperatively at 3 locations in the cubital tunnel before and after transposition using a laser Doppler flowmeter. Clinical results at 3, 6, and 12 months after surgery were also compared between the 2 groups.

Results The blood flow before ulnar nerve transposition was not significantly different between the groups. Blood flow at all 3 locations after the ulnar nerve transposition was significantly higher in the VP group than in the non-VP group. Blood flow in the non-VP group reduced to values between 28% and 52% from the pre-transposition baseline values. After surgery, no significant differences were observed in the clinical results between the groups, except for the Disabilities of the Arm, Shoulder and Hand scores at 12 months after surgery, which was greater in the non-VP group.

Conclusions The procedure of preserving the extrinsic vascular pedicles can prevent compromise of blood flow to the ulnar nerve immediately after nerve transposition. However, this procedure had no correlation to improved recovery of ulnar nerve function after surgery. *(J Hand Surg Am. 2014;39(2):291−302.*

Type of study/level of evidence Therapeutic II.

Key words Ulnar nerve, blood flow, cubital tunnel syndrome, laser Doppler flowmeter nerve transposition.

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Several procedures are available for the treatment of cubital tunnel syndrome (CubTS). Subcutaneous anterior ulnar nerve transposition may be the procedure of choice for CubTS caused by elbow osteoarthritis (OA) because of the following biomechanical changes: (1) the cubital tunnel floor in an elbow with OA is abnormally shallow owing to the presence of osteophytes or deformity of the elbow joint; (2) the distance from the center of rotation of the elbow joint to the course of the ulnar nerve becomes greater, which may result in increased tension on the nerve; (3) cubital tunnel pressure has been

found to be greater in OA elbows than in non-OA elbows[1]; and (4) The anteriorly transposed ulnar nerve is not stretched with maximal elbow extension because maximum degree of extension is restricted by elbow OA. One drawback of subcutaneous anterior transposition, however, is the possible compromise of the blood supply to the nerve after extensive dissection.[2–4] Restoration of intraneural blood flow is critical for recovery of peripheral nerve function after chronic compression.[5–7] Therefore, preserving the vascular pedicles of the ulnar nerve during subcutaneous anterior transposition could have the advantage of better clinical results; however, it has disadvantages such as longer operative time, the need to perform careful dissection, and the risk of further vascular damage. Ogata et al[8] demonstrated that anterior transposition without a vascular pedicle was associated with a significant decrease in regional blood flow to the ulnar nerve in their monkey models.

In light of this, a method for anterior transposition of the ulnar nerve that preserves the extrinsic nutrient arteries was developed.[4,9] Although this method is theoretically appealing and has been evaluated in several series,[4,8–12] the data are insufficient for conclusive evaluation of results because of lack of blood flow measurements or because of problems in the study design. Therefore, whether this procedure has a positive effect on clinical outcomes remains unclear. To date, animal or human data that directly assess blood flow using this technique have been limited.[4,8–13]

The purposes of the present study were to investigate changes in blood flow to the ulnar nerve in vivo in humans and their effects on clinical results of ulnar nerve transposition with or without preservation of the vascular pedicles.

MATERIALS AND METHODS

Patients

Institutional review board approval was obtained before commencing this study. The principal inclusion criterion was CubTS associated with elbow OA with a sensory or motor deficit confirmed by physical examination and nerve conductive studies. The exclusion criterion was CubTS caused by idiopathic or conditions other than OA, including contusion, dislocation, and fracture. Patients with tardy ulnar nerve palsy associated with cubitus valgus or varus were also excluded, as were those with a history of decompression of the ulnar nerve. The OA changes in the affected elbows were evaluated based on anteroposterior, lateral, and cubital tunnel radiographs.[14] Elbows classified as grade 3, 4, or 5 of the Kellgren-Lawrence scale[15] were considered to have OA. A total of 36 patients (29 men and 7 women) met the inclusion criteria and were enrolled in the study. Their mean age was 66 years (range, 51–80 y). The mean restricted extension angle of the elbow joint was 14° (range, 0°–35°), and the mean flexion angle was 122° (range, 105°–145°). The most common physical findings were a Tinel sign at the cubital tunnel, a positive elbow flexion test,[14,16] decreased strength of the abductor digiti minimi and first dorsal interosseous muscle, and sensory disturbance in the distribution of the ulnar nerve. Electrodiagnostic studies confirmed decreased motor ulnar nerve conduction (MCV) and/or sensory ulnar nerve conduction velocities across the affected elbow (<50 m/s). The patients were randomly selected on the day of surgery via an independent observer by choosing 1 of 2 opaque envelopes containing a card that indicated the patient to undergo vascular pedicles–sparing surgery for anterior ulnar nerve transposition (VP group) or nerve transposition and artery ligation (non-VP group). Multiple surgeons, who are coauthors (K.N., S.U., T.I., M.H., H.M., and H.K.) of this study, performed the surgeries using a uniform procedure at a single institution.

Surgical procedure

A curved skin incision approximately 13 cm long was made posterior to the medial epicondyle. The medial antebrachial cutaneous nerve was preserved. The ulnar nerve was identified at the proximal end of the cubital tunnel, and the cubital tunnel retinaculum, composed of the deep investing fascia of the flexor carpi ulnaris (FCU) muscle and the arcuate ligament of Osborne,[17] was incised. The arcade of Struthers[18] was incised, and the medial intermuscular septum of the arm was resected for 10 cm proximal to the medial epicondyle to allow anterior displacement of the nerve without tension or kinking. The articular branch of the ulnar nerve was cut. If the tension of the most proximal motor branch to the ulnar head of the FCU was too tight for transposition, it was cut or dissected from the main nerve trunk. Any cysts or loose bodies in the cubital tunnel were removed.

We identified the 3 main extraneural arteries in all the cases, namely the superior ulnar collateral artery (SUCA), the inferior ulnar collateral artery (IUCA), and the posterior ulnar recurrent artery (PURA; Figs. 1 and 2).[4,12,19,20] The SUCA generally originates from the brachial artery at an average of 179 mm proximal to the medial epicondyle and runs parallel with the nerve. The IUCA originates from the brachial artery at an average of 66 mm proximal to the medial