Repair of a median nerve transection injury using multiple nerve transfers, with long-term functional recovery

Case report

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Complete loss of median nerve motor function is a rare but devastating injury. Loss of median motor hand function and upper-extremity pronation can significantly impact a patient’s ability to perform many activities of daily living independently. The authors report the long-term follow-up in a case of median nerve motor fiber transection that occurred during an arthroscopic elbow procedure, which was then treated with multiple nerve transfers. Motor reconstruction used the nerves to the supinator and extensor carpi radialis brevis to transfer to the anterior interosseous nerve and pronator. Sensory sensation was restored using the lateral antebrachial cutaneous (LABC) nerve to transfer to a portion of the sensory component of the median nerve, and a second cable of LABC nerve as a direct median nerve sensory graft. The patient ultimately recovered near normal motor function of the median nerve, but had persistent pain symptoms 4 years postinjury.

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KEY WORDS • median nerve • nerve transection • nerve transfer • peripheral nerve

The use of nerve transfers is now a well-accepted reconstructive technique that can be used to repair a variety of peripheral nerve injuries.17,27–29 Optimal muscle reinnervation depends on regenerating motor axons reaching their target muscles within 12–18 months of denervation.1,5,7,8,10 Functional recovery is compromised by deterioration of trophic and substrate support for regenerating axons in long-term denervated distal nerve stumps. This includes a progressive fall in the regenerative capacity of axotomized neurons and denervated Schwann cells with time and distance. By 12–24 months irreversible changes occur; these include muscle fiber fragmentation, fibrosis, and disintegration, with eventual replacement of muscle by fat cells.4,11,15,30 Neurological recovery is also dependent on healthy viable muscle tissue. This is necessary for the release of nerve growth factors from denervated muscle. These factors act as a catalyst to stimulate the axon to regenerate. If the denervated muscle becomes fibrotic these factors may no longer be released, and the muscle tissue must also remain viable and electrically active if a regenerating axon is going to establish a connection with a functional neuromuscular junction.4,11,15,30 Long-term denervated muscle will eventually become fibrotic and electrically inactive. Reinnervation must occur not only before the muscle undergoes irreversible changes, but before the endoneural tubes will no longer support nerve regrowth.4,11,15,30

Using donor motor nerves that are in proximity to the target muscles minimizes denervation time, which helps to ensure that muscle reinnervation occurs before the onset of irreversible changes.16–18,23.25 Unlike tendon transfers, nerve transfers do not require prolonged postoperative immobilization21 and restore function to the muscle in its original position and optimal sarcomere length. We report a case of iatrogenic median nerve injury due to a nerve transection during elbow joint arthroscopy. Motor deficits were treated using redundant radial nerve branches to the AIN and the pronator nerve. Sensory reconstruction used a transfer from the LABC nerve to a portion of the sensory component of the median nerve.

Case Report

History and Examination. This 56-year-old right-hand-dominant woman received a diagnosis of medial epicondylitis. After a trial of conservative therapy she underwent arthroscopy of her right elbow with synovectomy.
Nerve transfer for repair of median nerve transection

tomy. Immediately postoperatively she experienced reduced function of her thumb, index and long fingers, and had decreased sensation especially in her index finger and thumb, and these did not improve over a 5-month period. The patient was subsequently referred to us for further evaluation and management. On examination 2 arthroscopy ports at the elbow were noted, and she had no right median nerve function. She had an abnormal appearance of the index finger, with atrophic changes. On examination she had no median motor function. Pinch and grip on the right were 2 and 20 lbs, respectively, and on the left they were 12 and 50 lbs. Thenar strength was satisfactory, but not normal. Ulnar nerve function was normal. She had a positive Tinel sign, strongest just over the antecubital crease, and a second distal Tinel sign at the pronator entrapment point in the proximal forearm. The Tinel was in the distribution of the third web space of the median nerve and did not extend into the thumb or index finger.

Electromyography studies confirmed a proximal right median sensorimotor neuropathy. This was supported by small median compound muscle action potential amplitude and absent median sensory nerve action potentials. There was evidence of active degeneration of all muscles tested. At that point she declined further surgery and opted for conservative therapy including a wrist splint and Lyrica for neuropathic pain. Repeat studies obtained 1 month later again demonstrated no evidence of reinnervation in the AIN.

Operation. Eight months after the initial injury the patient underwent an exploration of the median nerve. An incision was made in the proximal forearm. After a step-lengthening tenotomy of the superficial tendon of the PT we identified the median nerve proximally. Compression of the median nerve by a tendinous band of the deep head of the PT was apparent. This was released, and distally the median nerve looked completely denervated, with no bands of Fontana noted. Just proximal to this entrapment point the nerve was equally denervated. The median nerve was followed proximally into dense scar tissue. Thus the incision was extended above the elbow. The median nerve had been injured at 3 levels along its course (Fig. 1). Only 2 fascicles on the more ulnar side of the sensory component of the median nerve were intact. These would correspond to the sensory fascicle to the third web space of the median nerve and the finding of the distal Tinel sign. Using magnification and microinstrumentation, a slow and tedious neurolysis was done to protect these 2 fascicles.

Once the neurolysis had been performed, it was clear that the rest of the median nerve was completely transected. Both proximal and distal to the transection, the motor and sensory components of the median nerve were identified topographically. The radial nerve was then explored, as were the components of the radial nerve, the posterior interosseous nerve, the nerve to the supinator, the radial sensory nerve, and the nerve to the ECRB (Fig. 2). A branch of the nerve to the ECRB was transferred to the pronator nerve, and the nerve to the ECRB and the supinator were transferred to the AIN (Fig. 3). The LABC nerve was transferred to the sensory component of the median nerve. Then, a graft from the more distal component of the LABC nerve was used for an 8-cm graft from the sensory component of the median nerve proximally to its remainder distally (Fig. 4). Marcaine was placed in this incision, as was a drain and the pump for pain medication. There was no tension on the nerve repair sites. The incision was closed in the standard fashion.

Postoperative Course. Postoperatively, the patient participated in active physical therapy and motor reeducation. She was placed in a light nonimmobilizing dressing. A sling was used for 1 week. Nerve gliding and range of motion exercises were begun at 1 week. Motor retraining similar to that used in tendon transfer, with cocontraction of the donor and recipient muscles was used. She was seen for follow-up in the immediate postoperative period at 2 weeks, 4 weeks, 2 months, 6 months, and at 1, 2, 2.5, and 4 years. Distal IP flexion of the index finger was noted before FPL flexion. At 1 year she had 60° of active flexion of the distal IP joint of the index finger and 54° at
the IP joint of the thumb at an M3 level of strength. Lateral key pinch at 2, 2.5, and 4 years was 8, 10, and 9 lbs, respectively. At 4 years postrepair, she reported excellent functional improvement. Reinnervation had occurred in the muscles of the median nerve and she had some sensation in her thumb and index finger, all relating to the nerve reconstruction. Pinch and grip on the right was 9 and 36 lbs on the left. She had almost normal median motor function, with a 5° extension lag of her index finger and 4/5 power in the FPL (Table 1).

Light touch perception was present in the median nerve distribution, but the patient had no 2-point discrimination. She had since returned to full-time employment and was able to complete all of her activities of daily living independently. Unfortunately she was markedly affected by throbbing pain and coldness in the median nerve sensory distribution of her right hand. This was refractory to gabapentin, lidocaine patches, and sensory reeducation.

Discussion

Median nerve injury is the most common iatrogenic upper-limb nerve injury requiring surgical repair. In our case synovectomy and resection of bone fragments was performed around the coronoid process, where the neurovascular structures are in proximity to the anterior capsule. This increases the risk of inadvertent nerve damage and may have contributed to the unusual proximal median nerve transection experienced by our patient. Delayed presentation similar to that in our case is not unusual with iatrogenic peripheral nerve injuries. At least two-thirds of patients do not undergo surgery for the iatrogenic injury within an optimal time interval due to delayed referral. Our patient was referred within 6 months of the injury; however, patients referred in a delayed fashion can be treated with tendon transfers to restore thumb opposition and finger flexion.

Although tendon transfers can restore the majority of median nerve function, the restoration of meaningful pronation is often lacking. Given the nature of this patient’s injury along multiple segments of the nerve, grafting would not have been an ideal treatment strategy, due to the long segment of nerve graft that would be required. The literature suggests that reinnervation of motor endplates must be completed within 12–18 months to achieve meaningful recovery. In contrast to direct repair and nerve grafts, nerve transfers shorten the distance for nerve regeneration to target motor endplates. We have previously described the use of the radial nerve both to reinnervate the median hand and to restore pronation. Given the delay to surgery and the nature of multiple injury sites, nerve transfers represented the most logical initial treatment option.

Similar to patients with AIN syndrome, the rate of recovery in our patient was more rapid in the FDP than in the FPL. We postulate that FPL recovers strength slower than FDP because it resides on the right of the muscle force curve. Splinting of the IP joint to block IP extension may be viable as a means of preventing FPL lengthening and aiding motor recovery.

Our patient attained an excellent motor recovery and was able to return to full-time employment; however, she continued to experience persistent moderate arm pain, sensory loss, and cold sensitivity in her hand. These symptoms resulted in significant disability and depression, an issue.
Nerve transfer for repair of median nerve transection highlighted by Novak et al.20 Motor deficits are just one facet of a peripheral nerve injury. Ultimately a peripheral nerve injury is a multidimensional construct, and the multidisciplinary treatment of the associated pain and disability it causes may be as important if not more important than motor recovery for a large proportion of patients.

Although this report only represents a single anecdotal case, it emphasizes the increase in motor strength over a 4-year period. Based on this case, we now advise patients with nerve transfers that increased strength can continue even to 4 years after surgery.

Conclusions

Excellent motor function can be achieved using nerve transfer for treatment of a median nerve complete motor transection even after a delayed presentation. However, pain is as important as motor function in contributing to significant disability and needs to be carefully addressed.

Disclosure

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

Author contributions to the study and manuscript preparation include the following. Conception and design: all authors. Acquisition of data: all authors. Analysis and interpretation of data: Mackinnon. Drafting the article: all authors. Critically reviewing the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Mackinnon. Administrative/technical/material support: Mackinnon.

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