Lateral Branch of the Thoracodorsal Nerve (LaT Branch) Transfer for Biceps Reinnervation

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Summary: In cases of significant upper extremity trauma, the thoracodorsal nerve is a reliable secondary option for the restoration of elbow flexion. In all previous descriptions, however, the entire nerve is transferred. We describe a case utilizing the lateral thoracodorsal nerve (LaT) branch for biceps reinnervation with an associated cadaver study. Transfer of the LaT branch to the biceps branch was performed on a patient who had sustained a traumatic brachial plexus injury that left him without elbow flexion. Also, 4 cadavers (8 upper extremities) were dissected to identify the bifurcation of the thoracodorsal nerve and confirm the feasibility of transferring the LaT branch to the biceps motor branch. Axon counts of the thoracodorsal proper, LaT branch, musculocutaneous proper, and the biceps branch were also obtained. A bifurcation of the thoracodorsal nerve was present in all cadaver specimens, with an average distance of 7.5 cm (range, 6.2–9.8 cm) from the insertion of the latissimus dorsi muscle. Axon counts revealed a donor-to-recipient ratio of 0.85:1. Follow-up of our patient at 1 year showed improvement of elbow flexion manual muscle testing grade from 0 to 4/5. Furthermore, electromyography at 1 year confirmed biceps reinnervation and showed normal readings of the latissimus compared with preoperative electromyography. Transfer of the LaT branch is a viable and minimally morbid option for biceps reinnervation after traumatic brachial plexus injury. Further follow-up of our patient and larger prospective studies are needed to understand the true potential of this nerve transfer.

METHODS

Case Report

Our patient is a 45-year-old man who sustained a self-inflicted gunshot wound to the right chest. He presented
6 months after injury with a patchy but global brachial plexus deficit, including a manual muscle testing (MMT) grade of 0/5 for elbow flexion. Electromyography (EMG) showed partial or complete injury to the median, ulnar, radial, musculocutaneous, axillary, and lateral pectoral nerves. Therefore, the preoperative plan was to transfer the thoracodorsal nerve proper, which was electro-diagnostically intact, to the biceps branch of musculocutaneous nerve. In the operating room with the patient supine, an incision was made along the medial aspect of the upper arm to expose the musculocutaneous nerve and its biceps branch. Once these were isolated, the incision was extended through the axilla and onto the upper lateral chest to expose the thoracodorsal nerve. After the bifurcation was identified, the LaT branch appeared to be of similar size to the biceps branch (see figure, Supplemental Digital Content 1, which displays photos of the surgical procedure showing (A) exposure, (B) isolation of the biceps branch (yellow loop) and LaT branch (blue vessel loop), (C) transfer of the LaT branch to the biceps branch, and (D) coaptation, http://links.lww.com/PRSGO/A684). At that point, it was decided to transfer only the LaT branch to preserve some latissimus function. Internal neurolysis of the LaT branch was performed to gain adequate length, and neurorrhaphy was performed utilizing 8-0 nylon suture. The patient was placed in a long arm splint and stayed 1 night in the hospital. He was seen at 2, 4, and 12 months and underwent electrodiagnostic testing at 2 and 11 months.

Cadaver Dissection

Four cadaver torsos were obtained from the University of Pittsburgh School of Medicine. Dissection was performed on 8 upper extremities to identify the thoracodorsal nerve and its bifurcation and identify the location of the bifurcation with respect to its distance from the latissimus dorsi insertion on the humerus. Segments of the LaT branch, biceps branch, thoracodorsal nerve, and musculocutaneous nerve were sent to pathology for histology and stained with luxol fast blue. Photographs of the sections were taken using a Nikon 90i (Melville, NY) microscope camera and axon counts for each nerve were

Fig. 1. Follow-up at 12 months. Our patient displayed fuller contraction of the biceps muscle on resting (A) compared with active flexion (B).

Fig. 2. A, Results of cadaver dissection showing anterior view of the thoracodorsal nerve bifurcation (arrowhead) and its relationship to the latissimus insertion (arrow). B, With minor neurolysis, the LaT branch (arrowhead) easily transfers to the biceps branch (arrow).
made using image J (National Institutes of Health, Bethesda, MD).

RESULTS

Case Report

Our patient had no complications. Electro-diagnostics of the right latissimus dorsi at 2 months did not demonstrate any abnormality on EMG testing, consistent with preoperative findings. Not unexpectedly, there were no new signals noted in the biceps muscle at this time. At 4 months, our patient had progressed to MMT grade of 4/5 for elbow flexion, with visible firing of his biceps tendon when asked to actively flex the elbow. By 11 months, the electro-diagnostics demonstrated improvement in biceps, with recruitment of 20% of the motor unit pool compared with the contralateral side, a significant increase from previous EMG. Readings of the right latissimus remained normal. Furthermore, our patient had progressed to an MMT grade of 4/5 with dramatic increase in visible contraction of the biceps (Fig. 1). Overall, the patient was extremely satisfied with the results of the transfer.

Cadaver Dissection

The thoracodorsal nerve bifurcated before entering the muscle in all specimens, and the LaT branch was transferrable to the biceps branch in all cases with only limited internal neurolysis (Fig. 2). On average, the thoracodorsal nerve bifurcation was located 7.5 cm ± 1.18 cm (range, 6.2–9.6 cm) inferior to the latissimus insertion on humerus. Axon counts revealed that, on average, the LaT branch contained 1,453 ± 289 axons, the biceps branch contained 1,715 ± 699 axons, the thoracodorsal nerve contained 2,789 ± 707 axons, and the musculocutaneous nerve contained 6,784 ± 2,545 axons. The resulting donor-to-recipient axon count ratio for the LaT branch to biceps branch is 0.85:1.

DISCUSSION

This is the first report of transfer of the LaT branch for the restoration of elbow flexion. The patient in this case showed significant improvement in elbow flexion at 11 months, and the results of our cadaver dissection revealed similar axon counts to previous reports, yielding a favorable donor-to-recipient nerve axon count ratio of 0.85:1. Schreiber et al.9 recently published a study analyzing the various options for biceps reinnervation, looking specifically at the axon counts of the respective nerves compared with that of the biceps branch. After correlating clinical outcomes to donor-to-recipient nerve axon count ratio, the authors concluded that a ratio greater than 0.7:1 was necessary to achieve a successful outcome. The LaT branch to biceps branch ratio from our study falls well into this range.

In cases of severe trauma, donor nerve options are limited. Additionally, when considering nerves for transfer, thought should be given to preserving as much residual function as possible. The case and cadaver dissection presented in our study demonstrates the efficacy and feasibility of the LaT branch for use in reinnervation of the biceps brachii muscle. The nerve is present in a reliable location and can easily swing over to the biceps branch of the musculocutaneous with minimal internal neurolysis, if necessary. It also spares the medial branch of the thoracodorsal, resulting in no obvious functional postoperative morbidity. We hypothesize that when the LaT branch is available, it provides a low morbidity option for biceps reinnervation. Studies with a larger cohort and longer follow-up are needed to better understand the potential and limits of this procedure.

REFERENCES

1. Mackinnon SE, Novak CB. Nerve transfers. New options for reconstruction following nerve injury. Hand Clin. 1999;15:645–666.
2. Merrell GA, Barrie KA, Katz DL, et al. Results of nerve transfer techniques for restoration of shoulder and elbow function in the context of a meta-analysis of the English literature. J Hand Surg Am. 2001;26:303–314.
3. Oberlin C, Béal D, Leechavengvongs S, et al. Nerve transfer to biceps muscle using a part of ulnar nerve for C5-C6 avulsion of the brachial plexus: anatomical study and report of four cases. J Hand Surg Am. 1994;19:232–237.
4. Mackinnon SE, Novak CB, Myckatyn TM, et al. Results of reinnervation of the biceps and brachialis muscles with a double fascicular transfer for elbow flexion. J Hand Surg Am. 2005;30:978–985.
5. Tung TH, Mackinnon SE. Nerve transfers: indications, techniques, and outcomes. J Hand Surg Am. 2010;35:332–341.
6. Novak CB, Mackinnon SE, Tung TH. Patient outcome following a thoracodorsal to musculocutaneous nerve transfer for reconstruction of elbow flexion. J Plast Reconstr Aesthet Surg. 2009;62:510–515.
7. Glassey N, Perks GB, McCulley SJ. A prospective assessment of shoulder morbidity and recovery time scales following latissimus dorsi breast reconstruction. Plast Reconstr Surg. 2008;122:1334–1340.
8. Tobin GR, Schusterman M, Peterson GH, et al. The intramuscular neurovascular anatomy of the latissimus dorsi muscle: the basis for splitting the flap. Plast Reconstr Surg. 1981;67:637–641.
9. Schreiber JJ, Bryn DJ, Khair MM, et al. Optimal axon counts for brachial plexus nerve transfers to restore elbow flexion. Plast Reconstr Surg. 2015;135:135e–141e.
10. Raksakulkiat R, Leechavengvongs S, Malungpaishrope K, et al. Restoration of winged scapula in upper arm type brachial plexus injury: anatomic feasibility. J Med Assoc Thai. 2009;92:S244–S250.