Long-Nerve Grafts and Nerve Transfers Demonstrate Comparable Outcomes for Axillary Nerve Injuries

Scott W. Wolfe, MD, Parker H. Johnsen, BS, Steve K. Lee, MD, Joseph H. Feinberg, MD

Purpose To compare the functional and EMG outcomes of long-nerve grafts to nerve transfers for complete axillary nerve palsy.

Methods Over a 10-year period at a single institution, 14 patients with axillary nerve palsy were treated with long-nerve grafts and 24 patients were treated with triceps–to–axillary nerve transfers by the same surgeon (S.W.W.). Data were collected prospectively at regular intervals, beginning before surgery and continuing up to 11 years after surgery. Prior to intervention, all patients demonstrated EMG evidence of complete denervation of the deltoid. Deltoid recovery (Medical Research Council [MRC] grade), shoulder abduction (°), improvement in shoulder abduction (°), and EMG evidence of deltoid reinnervation were compared between cohorts.

Results There were no significant differences between the long-nerve graft cohort and the nerve transfer cohort with respect to postoperative range of motion, deltoid recovery, improvement in shoulder abduction, or EMG evidence of deltoid reinnervation.

Conclusions These data demonstrate that outcomes of long-nerve grafts for axillary nerve palsy are comparable with those of modern nerve transfers and question a widely held belief that long-nerve grafts do poorly. When healthy donor roots or trunks are available, long-nerve grafts should not be overlooked as an effective intervention for the treatment of axillary nerve injuries in adults with brachial plexus injuries. *(J Hand Surg Am. 2014;39(7):1351–1357. Copyright © 2014 by the American Society for Surgery of the Hand. All rights reserved.)*

Type of study/level of evidence Therapeutic III.

Key words Axillary nerve, brachial plexus, nerve graft, nerve transfer, outcomes.

BRACHIAL PLEXUS INJURIES in adults are most commonly the result of high-speed vehicular trauma and can debilitate a predominantly young, healthy, active group of individuals. A number of surgical treatment options have been described, including nerve repair, nerve graft, and nerve transfer.[1,2] Several authors have demonstrated relatively poor outcomes in patients treated with long-nerve grafts for brachial plexus injuries.[3–5] Terzis and Barmpitsioti[6] reported that patients who received nerve grafts longer than 6 cm experienced significantly worse outcomes than those with short nerve grafts ($P < .02$). In a 2011 systematic analysis comparing the results of nerve transfers and nerve grafts in patients with traumatic upper plexus (C5-6 or C5-6-7) palsy, Garg et al[7] demonstrated superior outcomes of shoulder and elbow function in patients treated with nerve transfers over those treated with nerve grafts. Indeed, nerve transfers for axillary nerve

From the Center for Brachial Plexus and Traumatic Nerve Injury, Hospital for Special Surgery, New York, NY.

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Corresponding author: Scott W. Wolfe, MD, The Hospital for Special Surgery, 535 E. 70th St., New York, NY 10021; e-mail: wolfes@hss.edu.

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palsy, particularly triceps—to—axillary nerve transfers, have been associated with high success rates in several small series.[8—10]

Lee and colleagues[11] reported less satisfying results in a series of 21 patients who had undergone triceps—to—axillary nerve transfer for isolated axillary nerve palsy. Their patients demonstrated an average Medical Research Council (MRC) strength of 3.5 at an average of 21 months follow-up, with 5 patients failing to gain antigravity function. Negative prognostic factors included time to surgery, age, and body mass index. We share the concerns of these authors regarding the predictability of the triceps transfer, particularly in patients with partial C7 injury. Concurrently, we have been impressed with the outcomes of carefully selected patients who have undergone grafts longer than 10 cm from the C5 or C6 root for axillary nerve restoration at our institution. The purpose of this investigation was to compare the functional and EMG outcomes of long-nerve grafts with the outcomes of triceps—to—axillary nerve transfers for the treatment of complete axillary nerve palsy.

METHODS

Over a 10-year period at a single institution, 14 patients with axillary nerve palsy were treated with long-nerve grafts and 24 patients were treated with triceps—to—axillary nerve transfers by the same surgeon (S.W.W.). Patients were excluded if they did not have EMG evidence of complete denervation of all 3 heads of the deltoid before surgery or if they did not have at least 9 months of postoperative follow-up. This left 10 graft patients and 14 transfer patients. Eight of 10 graft patients and 10 of 14 transfer patients had a concomitant injury to the suprascapular nerve (SSN) with EMG evidence of supra- and infraspinatus denervation. Reinnervation of the SSN by spinal accessory transfer was concomitantly performed in 7 graft patients and 8 transfer patients and by graft from C5 to the SSN in 1 transfer patient. Reinnervation of the SSN was not attempted in 1 graft patient owing to trapezius palsy and in another who had recovering SSN function that required neurolysis alone. There was 1 C5-6 injury, 3 C5-6-(partial) C7 injuries, and 6 5-level injuries in the graft group. In all patients in the graft group, the C5-6 component was a postganglionic injury, characterized by retained innervation of the rhomboids, paraspinal musculature, and serratus anterior. The 2 C5-6 graft patients without concomitant injury to the SSN had complete injuries of the upper trunk just distal to the SSN. Cervical 5-6-7 (partial) injuries were complete postganglionic C5-6 injuries with partial C7 postganglionic injury as defined by preoperative EMG. Three transfer patients had isolated axillary nerve palsy. In the remaining transfer patients, there were 6 C5-6 injuries, 5 C5-6-(partial) C7 injuries, and no 5-level injuries. In those transfer patients with partial C7 injuries, preoperative EMG analysis of the triceps demonstrated intact motor units in all 3 heads of the triceps with variable but mild degrees of denervation in 1 or 2 heads in 3 of the 5 patients.

There were 9 men and 1 woman in the graft group and 14 men in the transfer group. Average age was 28 years (range, 17—39 y) in the graft group and 38 years (range, 26—73 y) in the transfer group. Nine of 10 in the graft cohort and 11 of 14 in the transfer cohort were injured in an automobile or a motorcycle accident. The remaining patient in the graft cohort was injured by a blow to the shoulder by a steel plate. The other mechanisms of injury for the transfer cohort were a skiing accident, a traction injury, and a resection of a malignant sheath tumor involving the C5 nerve root.

Surgical technique (nerve graft)

Axillary nerve grafts were performed as part of a comprehensive brachial plexus reconstruction. Seven nerve grafts were from C5 to the axillary nerve, 2 were from the posterior cord to the axillary nerve posteriorly, and 1 was from the posterior division of the upper trunk to the axillary nerve anteriorly. Patients with upper trunk injuries were placed in a modified lateral decubitus position on a beanbag so they could be turned during surgery to enable access to the axillary nerve posteriorly when indicated. Patients with 5-level injuries were placed in a modified beach chair position. C5 and C6 root levels were routinely explored in all patients to search for viable donor roots. Following neurolysis, somatosensory evoked potentials were elicited from each root. Stimulation was performed using a stimulator probe held in place by the surgeon. A tripolar stimulating probe with a single cathode between 2 anodes provided focused stimulation while minimizing stimulus artifact (Electrode Store, Enumclaw, WA; Inomed, Emmendingen, Germany). Recording was performed using a standard evoked potential recording system (eg, Cadwell Cascade, Kennewick, WA). Stimulation was performed at a rate of approximately 4/s, 200-microsec pulse duration, and stimulus intensity of typically 1 to 3 mA. Only patients with positive somatosensory evoked potentials (SSEPs) were considered for nerve grafting. Motor evoked potentials were not routinely performed. Electrical readings were interpreted by a