**EDITORIAL**

Modified extended approach improves recovery following spinal accessory to suprascapular nerve transfer

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**B**rachial plexus injuries are severe and often disabling injuries that occur in up to 5% of high-energy accidents. Selecting the appropriate treatment relies on accurate grading and classification of the injury, whether partial or complete and pre- versus post-ganglionic. One of the most common types of injury is complete brachial plexus injury with no function of the upper extremity (flail arm), which unfortunately portends a poor recovery. This injury pattern is typically associated with a high frequency of pre-ganglionic injury, with avulsion of multiple nerve roots. Surgical treatment of these patients usually includes nerve transfers, which are especially challenging because of the limited availability of donor nerves to support functional recovery. The typical extra-plexal donors are the spinal accessory nerve, phrenic nerve, contralateral C-7, or intercostal nerves. A close anatomical relationship between the donor and recipient nerve is important in order to avoid the need for an interposition nerve graft with additional coaptation sites and potential loss of axons and resulting in poorer outcomes.

In complete brachial plexus injury, the most common technique for restoring shoulder stability, shoulder abduction, and external rotation is by neurotization of the spinal accessory nerve to the suprascapular nerve. Shoulder abduction is aided by supraspinatus muscle recovery and external rotation by infraspinatus muscle function, while reinnervation of rotator cuff muscles confers static and dynamic shoulder stability. In the study by Bertelli and Ghizoni published in this issue of the *Journal of Neurosurgery: Spine*, the authors present their extensive experience with and results of spinal accessory to suprascapular nerve transfers for shoulder stability, abduction, and external rotation in patients who have suffered complete brachial plexus injury.

This is a retrospective analysis of 110 cases involving patients operated on during 11 years by a single surgeon for shoulder stability and abduction reanimation by spinal accessory nerve to suprascapular nerve transfer together with restoration of elbow flexion by either spinal nerve root grafting, with or without phrenic nerve transfer or intercostal nerve transfer to the musculocutaneous nerve. During this period, the surgeon modified the surgical approach from a classic L-shaped incision in the early phase to an oblique/extended incision. The latter allows more distal exploration of the suprascapular nerve at the suprascapular notch and fossa and better exposure of the donor nerve (the spinal accessory nerve), thereby avoiding the use of an interposition nerve graft (used occasionally when utilizing the classic approach). Successful shoulder abduction was defined as at least 30° during examination at least 24 months after the surgery. The authors identified a significantly higher success rate in range of shoulder abduction and also a much higher range of external rotation function in the group of patients who were treated utilizing the oblique/extended approach (those treated during the second part of the study period). Notably, the results for shoulder abduction are quite remarkable but with the caveat that the technique the authors use on video for measuring rotation includes both glenohumeral and scapulothoracic contributions, while others have attempted to measure “pure” glenohumeral abduction. Readers should also note that the results noted for external rotation are for the degrees of rotation away from complete internal rotation with the forearm held at baseline against the chest wall. Future series should compare results using these criteria; we agree with the authors that these criteria provide a reliable index of shoulder movement on a functional basis for activities of daily living.

The strength of this paper is the patient cohort, which represents the largest series to date of spinal accessory to supraspinatus nerve transfer in complete brachial plexus injury, comparing the classic L approach with the more...
modern, and now routinely utilized,\textsuperscript{5} oblique approach. The additional value of the paper is the concept of using an “extended” anterior approach to reach the suprascapular notch area to find the nerve, which may be quite distal in in patients with very severe stretch injuries avulsions. We too have employed this approach in several recent cases to find the nerve and to assess it for the rare “skip” lesion at the notch.

There are, however, some major limitations of this study that should be noted. First, this is an uncontrolled retrospective study of consecutive cases and includes surgeon-evaluated outcomes, which may bias the results. Second, comparing a recent cohort to a more remote one adds a confounding issue related to the improved experience of the surgeon and more experienced supporting team, with better understanding and implementation of the rehabilitation process and physiotherapy methods (which are now receiving greater focus for restoring function following nerve transfer procedures). All of these factors may contribute to the improved outcome of the patients who were treated during the more recent period. Another possible confounding factor lies with the high percentage (more than 50\%) of patients who were excluded from the study due to insufficient follow-up. The authors do not provide any information regarding recovery for these patients. Theoretically it is possible that patients did not return to follow-up because of dissatisfaction with a poor outcome, or alternatively, as a result of excellent recovery, so the overall results may appear better or worse than they truly are.

Nevertheless, this is the largest series to date of spinal accessory to suprascapular nerve transfer in patients with complete brachial plexus injuries, and the authors provide valuable information and pearls for current and future management of such cases. The concept of an extended approach, which enables better anatomical exposure and evaluation of the donor spinal accessory nerve and recipient suprascapular nerve, is a major advance. We congratulate the authors on their series and their results and encourage them to undertake future studies that assess this approach in a prospective fashion and also evaluate patients’ quality of life and overall satisfaction.

References
1. Bertelli JA, Ghizoni MF: Results of spinal accessory to suprascapular nerve transfer in 110 patients with complete palsy of the brachial plexus. \textit{J Neurosurg Spine} [epub ahead of print February 12, 2016. DOI: 10.3171/2015.8.SPINE15434]

Disclosures
The authors report no conflict of interest.

Response
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Of the 565 patients who underwent surgery for brachial plexus injuries during the period from 2002 to 2012 in our institution, 75\% were found to have total palsy of the brachial plexus (Table 1). Such extended lesions mostly resulted from stretch injuries following motorcycle accidents.\textsuperscript{19} Unlike a clean cut, the stretch injury energy dissipates along the brachial plexus elements producing extended lesions. Hence, the possibility of extending the dissection up to a healthy distal nerve stump is crucial for success in an accessory to suprascapular nerve transfer. We always initiate dissection of the suprascapular nerve by the limited supraclavicular anterior approach. If we cannot find a healthy suprascapular nerve, we detach the trapezius from the clavicle to assess the suprascapular nerve retroclavicularly. If scar tissue prevents dissection, we expose the suprascapular nerve at the suprascapular fossa. Direct exposure of the suprascapular nerve at the suprascapular fossa saves time if the patient has clavicle fracture or dislocation or has had previous surgery. Dissection at this level is not easy, and venous bleeding should

\begin{table}[h]
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\hline
Type of Brachial Plexus Palsy & No. of Patients (\%) \\
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Supraclavicular injuries & 512 (91) \\
Total palsy & 257 (50) \\
Partial avulsion & 193 (75) \\
Total avulsion & 64 (25) \\
Upper type injuries & 240 (47) \\
C5–6 & 58 (24) \\
C5–7 & 48 (20) \\
C5–8 & 134 (56) \\
Lower type injuries & 15 (3) \\
C7–T1 & 10 (67) \\
C8–T1 & 5 (33) \\
Infraclavicular injuries & 53 (9) \\
\hline
\end{tabular}
\caption{Type of palsy and root involvement after brachial plexus trauma in a series of 565 patients who underwent surgery at our institution from 2002 to 2012*}
\end{table}

* Note that in total palsies, total root avulsion was much less frequent than partial avulsion, which means that a root was available for grafting in the majority of our cases. In the upper type injuries note the higher prevalence of C5–C7 root injury.