Ideas and Innovations

The Dorsal Approach to the Suprascapular Nerve in Neuromuscular Reanimation for Obstetric Brachial Plexus Lesions

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Obstetric brachial plexus palsy affects one in 2000 newborns; 10 percent of them need early or secondary surgical reconstruction. In direct plexus repair, the sensory and motor reanimation of the hand is the main goal, followed by elbow flexion and shoulder stability and motion. The shoulder is under the control of many muscles and, mainly, three nerves: the axillary nerve (for the deltoid muscle, participating in abduction), the suprascapular nerve (innervating the supraspinatus and infraspinatus muscles, the latter responsible for lateral rotation of the humerus) and the dorsal scapular nerve (for the rhomboid muscles participating in scapular stabilization).

The rotational balance in the shoulder is very important, as general motion patterns are completely different in a medially rotated arm. The "trumpet sign" well known in these children indicates that elbow flexion is executed with an abducted arm and a pronated forearm (Fig. 1).

As many children suffering obstetric brachial plexus palsy with or without direct plexus repair present a medial rotation position or contracture of the shoulder,[1] the reanimation of lateral rotation of the shoulder to prevent these deformities is an important goal.

This particular field of reconstructive surgery of the shoulder function includes various procedures such as contracture releases (the anterior release with coracoid shortening osteotomy and subscapular tendon lenghtening[1]) and tendon transfers (proximal latissimus dorsi tendon rerouting, combined transfer of teres major and latissimus dorsi).[4] The suprascapular nerve is the first motor branch exiting the upper trunk and is topographically located in the center of any obstetric brachial plexus lesion.

In children younger than 18 months, when the other motor functions have well recovered, an extraplexic neurotization of a non-reinnervated suprascapular nerve may be proposed, allowing recovery of the infraspinatus muscle, thus recreating the functional balance between lateral and medial rotators to the glenohumeral joint. This may be part of a standard brachial plexus exploration and reconstruction by an anterior supraclavicular approach[2,3,5] or be realized by an individual dorsal approach.

We describe here the dorsal approach to the suprascapular nerve and its extraplexic neurotization by the distal branch of the accessory nerve. We discuss the technical details, advantages, and indications of this technique in our personal experience.

Surgical Technique

Under general anesthesia and orotracheal intubation, the child is turned in prone position, the head turned on the opposite side (Figs. 2 and 3). The dorsal shoulder area is disinfected and draped. The operation is carried out with operative microscope or magnifying loupes. A 4-cm horizontal skin incision is made over the scapular spine. Subcutaneous tissue is sectioned and the insertion of the trapezius muscle on the scapular spine is identified. It is sharply detached, and the underlying muscle fibers are cut where they enter the periosteum. The trapezius muscle is gently de-

From the Reconstructive Microsurgery Unit, St. Franziskus Hospital. Received for publication January 27, 2003.

DOI: 10.1097/01.PRS.0000146871.94229.91

FIG. 1. The “trumpet sign” in elbow flexion.

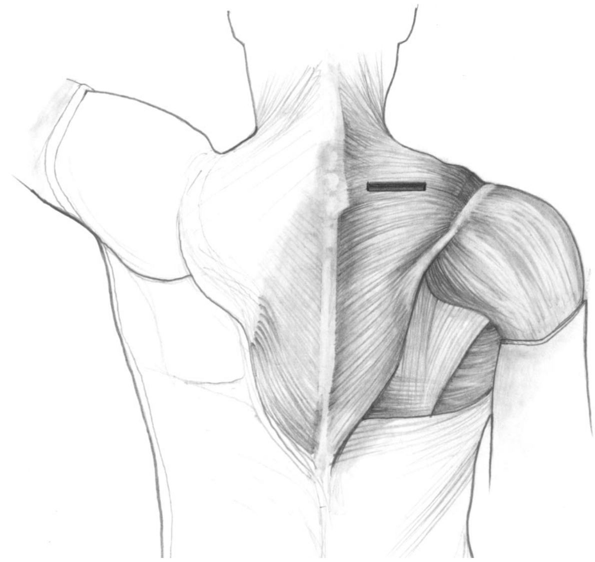

FIG. 2. Site of skin incision (dorsum, over the scapular spine).

tached until areolar tissue appears, which separates it from the supraspinatus muscle.

The dissection continues between the two muscles and is executed very carefully on the underside of the trapezius muscle, where the presence of fatty tissue indicates the neighborhood of the vascular bundle. The accessory nerve runs parallel to the trapezius muscle border 1 cm away from its distal margin on the undersurface and may be recognized easily after gently spreading the thin aponeurotic layer. It is then identified by electrical stimulation and put on a vessel loop. A self-retaining retractor is inserted between the trapezius muscle and the scapular spine, thus opening the intermuscular space and allowing more anterior access to the retroclavicular and supraclavicular space.

Medially, the deep cervical muscles and the omohyoideus may be identified; laterally one may palpate the coracoacromial ligament and the bony notch of the acromion. The suprascapular nerve runs medially to the ligament and laterally to the cervical muscles, within a fatty or fibrous envelope. It is identified by gentle and blunt dissection and hooked up on a vessel loop. When necessary, it can be found more distally under the ligament crossing the scapular notch and then may be followed to the branches innervating the supraspinatus and infraspinatus muscles but only by extensive dissection and thus harmful scarring.

Electrical stimulation of the suprascapular nerve allows its identification and some evaluation about its denervation and the muscle atrophy in the spinati. This may be judged by comparing the contraction force seen on the uninvolved trapezius muscle (supplied by an extraplexic nerve, the accessory XI) and the supraspinatus muscle while decreasing and increasing the current intensity (0.2 to a maximum of 5 mA by steps of 0.2 mA).

The neurotization procedure is only executed when there is evidence of diminished nerve conduction and a weak response in the supraspinatus muscle. In these cases, the suprascapular nerve is followed more proximally as far as possible and then is cut close to its emergence from the upper trunk without hurting the trunk. The distal branch of the accessory nerve is identified, and proximal collaterals entering the trapezius muscle are spared. The distal branch is followed as distal as possible and then cut out of the muscle. Nerve samples for neurohistopathology are taken at both ends (Fig. 4) and a classic epiperineurial nerve repair by single 10-0 sutures or by fibrin glue is performed as distally as possible to shorten the reinnervation time.

In two cases, only terminolateral anastomosis with a perineural window was done because of fair conduction within the suprascapular nerve without clinical function. In five other cases, only exploration without neurotization was done because of good muscle response.

The sutured nerve is set back and the distractor is removed. The trapezius muscle is sutured back to the scapular spine using periosteal Vicryl 3-0 mattress sutures. The opera-

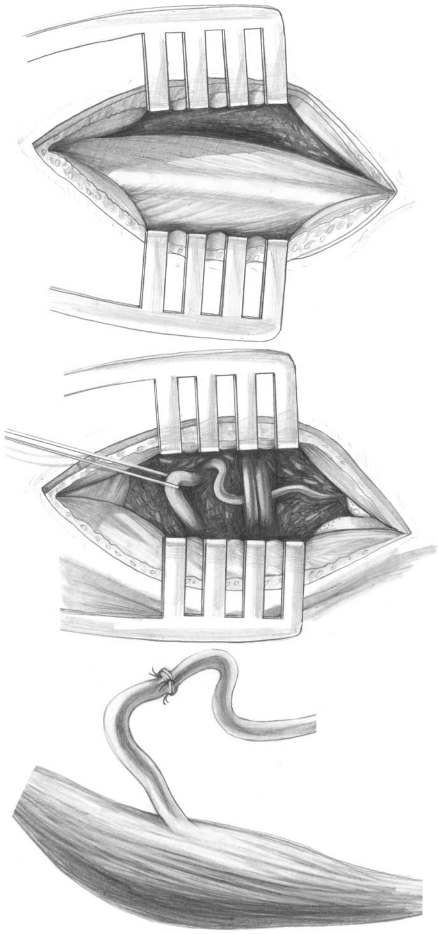

FIG. 3. (*Above*) Exposure over the scapular spine. (*Center*) In the areolar tissue above and ventral to the supraspinatus muscle, the suprascapular nerve and artery are identified. (*Below*) End-to-end anastomosis between the distal branch of the accessory nerve and the very distal suprascapular nerve.

tion is completed by a bilayer skin closure, including a dermal running suture. The arm is maintained adducted for 10 days by an elastic bandage. Head and neck are not immobilized. The skin suture is removed after 12 days and then full motion is authorized.

PATIENTS AND METHODS

Between 1996 and 2002, 470 patients aged from 1 month to 44 years with obstetric brachial plexus palsy were examined and over 180 operations were performed. Eighty secondary procedures involved the shoulder, and in 30 cases, the suprascapular nerve was explored by the dorsal approach. The indication for this procedure was absent active lateral rotation of the shoulder in a glenohumeral joint without any motion restriction.

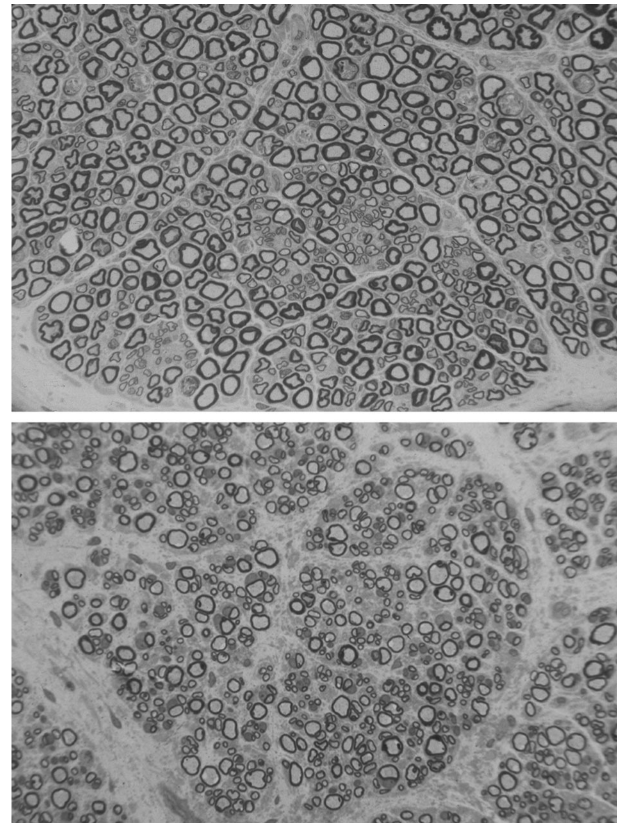

FIG. 4. Compared histopathology of suprascapular and accessory nerve (hematoxylin and eosin staining, magnification ×40).

In one of the earlier cases, the nerve could not be found and was supposed to have been badly injured, but in all other cases it could be identified. In five cases, the intraoperative electrical stimulation showed a normal peripheral neuromuscular response, so we did not cut the nerve. In two other cases, we performed an end-to side anastomosis by a lateral perineural window. In the remaining 23 cases, we performed the operation as described above. In the last three cases, we took histopathologic specimens from the proximal stump of the suprascapular nerve and the distal end of the accessory nerve (Fig. 4). The outcome remains individual but is excellent in selected cases (Fig. 5). It depends on the previous extent of muscle denervation, the reinnervation potential, and the cortical integration. Detailed results of neuromuscular reanimation of the lateral rotation in these shoulders will be published separately.

DISCUSSION

The restoration of the rotational balance of the shoulder is of primary importance for normal motion patterns in the upper limb and

FIG. 5. Clinical result after 8 months.

normal glenohumeral joint development.[1] A medially rotated arm favors elbow flexion with a pronated forearm, using the brachioradialis muscle instead the biceps. This movement is combined with shoulder abduction (trumpet sign); forearm supination is restricted. Even active shoulder abduction may be limited beyond 90 degrees.

When the glenohumeral joint is chronically positioned in medial rotation, a posterior pseudoglenoid develops, separated from the anterior "true" cavity by a ridge. This obviously hinders the ossification of the humeral head as shown by comparative radiographs (Fig. 6).

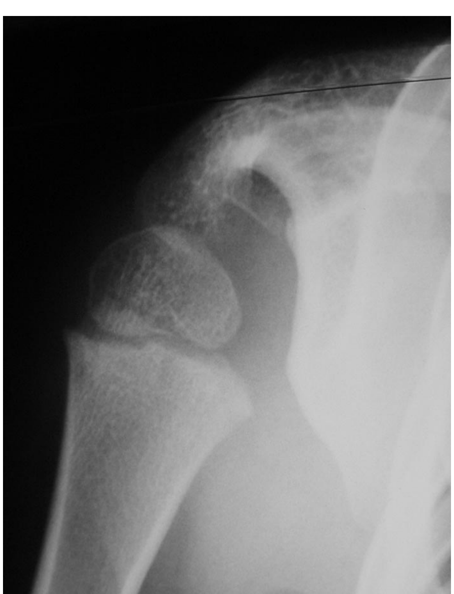

FIG. 6. Glenohumeral joint dysplasia in a child with severe and untreated medial rotation contracture of the shoulder with hypoplastic humeral head and flattened glenoid.

The natural balance of lateral (infraspinatus and supraspinatus) and medial rotators (latissimus dorsi, teres major, subscapularis, pectoralis major) is in favor of internal rotation. Moreover, the palsy of the suprascapular nerve in obstetric brachial plexus cases seems frequent (as it is located in the center of traumatic traction forces) and often without good recovery.

The dorsal approach leaves a small scar that is normally nearly invisible with normal clothes, but with a slight hypertrophy in rare cases. There is no disturbance of the transected local muscles. The medial and distal parts of the trapezius muscle lose their nerve supply, but this is well compensated.[2,3]

There is no preoperative and noninvasive tool assessing the motor function of the spinate muscles. Trials with noninvasive surface electromyography failed (probably as a result of a thick aponeurosis), and invasive needle electromyography specifically for the infraspinatus muscle requires sedation and careful detection of the intersection space with the trapezius to be sure about its activity.

Our practice relies on repetitive clinical testing and provocative maneuvers for active lateral rotation in upright and down position ("hands up"). We believe that this repair should be proposed in the selected cases with limited impairment because the procedure is safe, the nerve repair is reliable, the reinnervation is rapid, and the dorsal scar is short and acceptable.

We always explored the suprascapular nerve proximal to its course within the scapula.[5] Our stimulation test never suggested a two-level lesion; we therefore refused dissection of the muscle beds; this would increase direct muscular trauma and scarring.

We still have no answer for the cases lacking active lateral rotation of the shoulder and intraoperatively showing good local neuromuscular condition of the suprascapular nerve (normal conductivity) and good muscular trophism and response. These cases could be examples of unsatisfactory cortical integration of this movement in little children, some co-contraction pattern or very weak but trophic muscle not allowing movement against gravity, and thus needing muscle transfer for power enhancement.

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REFERENCES

1. Birch, R. Medial rotation contracture and posterior dislocation of the shoulder. In A. Gilbert (Ed.), *Brachial Plexus Injuries*. London: Martin Dunitz, 2001.
2. Dailiana, Z. H., Mehdian, H., and Gilbert, A. Surgical anatomy of spinal accessory nerve: Is trapezius functional deficit inevitable after division of the nerve? *J. Hand Surg. (Br.)* 26: 137, 2001.
3. Hattori, Y., Doi, K., Toh, S., and Baliarsing, A. S. Surgical approach to the spinal accessory nerve for brachial plexus reconstruction. *J. Hand Surg. (Am.)* 26: 1073, 2001.
4. Hoffer, M. M., Wickenden, R., and Ropper, B. Brachial plexus birth palsies: Results of tendon transfer to rotator cuff. *J. Bone Joint Surg. (Am.)* 60: 691, 1978.
5. Ozer, Y., Grossman, J. A. I., and Gilbert, A. Anatomic observations on the suprascapular nerve. *Hand Clin.* 114: 539, 1995.