Intraoperative Fluoroscopic Imaging for Suprascapular Nerve Localization During Spinal Accessory Nerve to Suprascapular Nerve Transfer

Nicole C. Cabbad, MD, MBA,* Kyle S. Nuland, MD,* Aravind Pothula, MD*

Distal fiber transfer of the spinal accessory nerve (SAN) to the suprascapular nerve (SSN) has been well described as an effective means to regain shoulder external rotation following upper trunk brachial plexus injuries. Both supine and prone positioning techniques have been described with comparable success. Whereas the posterior technique allows for sufficient distal length on the SAN for effective neurotization of the infraclavicular brachial plexus and SSN both proximal and distal to the suprascapular ligament, localization of the SSN within the suprascapular notch can be challenging and time intensive, especially in the obese patient. The use of intraoperative C-arm fluoroscopy is presented as a viable method for more exact suprascapular notch identification during dissection of the SSN. *(J Hand Surg Am. 2017;42(8):668.e1-e5. Copyright © 2017 by the American Society for Surgery of the Hand. All rights reserved.)*

Key words Brachial plexus, fluoroscopy, nerve transfer, peripheral nerve injury, surgical technique.

Online Exclusive

OBESITY IS AN EPIDEMIC THAT IS SWEEPING America, affecting children and adolescents. A total of 34.9% of adults over the age of 20 were found to be obese (defined as a body mass index [BMI] $>$ 30) and 16.9% of youth aged 2 to 19 were found to be obese ($\geq$ 95% of the sex-specific, Centers for Disease Control and Prevention BMI-for-age growth chart).[1] Therefore, surgeons will have to adjust their surgical approach to accommodate the dangers of an increased BMI population. When performing the spinal accessory nerve (SAN) to suprascapular nerve (SSN) transfer for recovery of shoulder abduction and external rotation, anatomical landmarks are critical for a safe and expeditious operation. The amount of subcutaneous tissue present can distort the surgical field and require retraction that renders preoperative skin markings inaccurate indicators of underlying anatomy. The identification of the suprascapular notch by palpation can often be the most time consuming and frustrating portion of the SAN to SSN transfer, even in a person with a normal BMI. The use of intraoperative fluoroscopy can easily expedite the location and identification of the suprascapular notch and underlying SSN. This can be especially useful in the obese patient who poses additional challenges.

*From the *Division of Plastic & Reconstructive Surgery, Department of Surgery, Montefiore Medical Center, Bronx, NY.*

Received for publication October 29, 2016; accepted in revised form May 20, 2017.

No benefits in any form have been received or will be received related directly or indirectly to the subject of this article.

Corresponding author: Nicole C. Cabbad, MD, MBA, Montefiore Medical Center, 111 E 210th St., Bronx, New York 10467; e-mail: drnccbd@gmail.com.

0363-5023/17/4208-0023$36.00/0
http://dx.doi.org/10.1016/j.jhsa.2017.05.022

INDICATIONS AND CONTRAINDICATIONS

The SAN to SSN transfer is indicated in instances of nonrecoverable SSN injury. This is confirmed by electromyography with lack of motor unit potentials in the supraspinatus performed at 12 to 15 weeks after injury.

The SAN to SSN transfer is ideally performed at 3 to 4 months after injury. Patient presentation after greater than 9 months should be considered a relative contraindication to surgery. Time of regeneration of the recipient nerve to the target muscle and eventual motor end plate fibrosis may preclude satisfactory motor outcome in these patients.

Severe medical and/or pulmonary comorbidities that preclude placement of the patient in the prone position for any extended period of time should be evaluated and optimized before surgery and may pose relative contraindications to surgery.

SURGICAL ANATOMY

Anatomy of the SSN

The SSN is formed by conjoined fibers from the C5 and C6 nerve roots, which extend off the upper trunk of the brachial plexus. It passes inferiorly and laterally deep to the omohyoid and trapezius muscles before traversing with the suprascapular vein and artery toward the suprascapular notch. At this point, the nerve travels deep to the suprascapular ligament and the artery and vein travel superficially. The nerve gives off 2 motor branches to the supraspinatus and subsequently travels inferolaterally to the spinoglenoid notch.[2] There has been a large discrepancy in the rate of cadavers reported to have a spinoglenoid ligament traversing this notch under which the suprascapular nerve may travel. Estimates for this ligament range between 15% and 80%.[3,4] After exiting the spinoglenoid notch, the nerve terminates by heading inferomedially to innervate the infraspinatus muscle. From a sensory perspective, cadaver studies have estimated that the SSN is responsible for roughly 70% of the shoulder joint sensory innervation.[5]

Osteology of the suprascapular notch

Whereas most surgical techniques described for SAN to SSN transfer from a posterior approach rely on tactile palpation of the suprascapular notch,[6–8] both the patient's body habitus and the specific suprascapular notch anatomy may complicate this process. The suprascapular notch is located on the superior border of the anterior scapula, just medial to the base of the coracoid process. More recent classification schemes have divided the suprascapular notch into 5 classes.[9] These include no discrete notch (type I, 8.3%); a notch longest in its transverse diameter (type II, 41.8%); a notch longest in its vertical diameter (type III, 41.8%); a bony foramen (type IV, 7.3%); and a notch and bony foramen (type V, 0.7%). Thus, palpation of the notch as an anatomical landmark during dissection could prove more difficult in types I, IV, and V notches, or in roughly 16% of the population.

SURGICAL TECHNIQUE

Utilizing the posterior approach as described by Colbert and Mackinnon,[7] the patient is first anesthetized in the supine position, before being transferred to the prone position on the operating table. A radiolucent operating table is used for the procedure. The arms are kept in an adducted position. The midline of the thoracic spinous processes is marked in a longitudinal fashion, followed by the lateral border of the acromion and the superior border of the scapular spine. A large mark corresponding to the location of the SAN is made 44% of the distance from the dorsal midline of the back to tip of the acromion, parallel to a line along the superior border of the scapula.[10] Subsequently, a similar mark is made estimating the position of the SSN at a point halfway between the medial border of the scapula and the acromion along the superior border of the scapula. A transverse incision is made connecting the marked locations of the SAN and SSN. Dissection is carried out using loupe magnification and continued just deep to the trapezius muscle. The trapezius muscle is divided parallel to its fibers, and a disposable nerve stimulator is utilized to pinpoint the distal motor branches of the SAN deep to the muscle. The surrounding adipose tissue is gently spread away from the nerve. The SAN is then tagged with a vessel loop.

Attention is then turned to identification of the SSN within the suprascapular notch. Dissection is carried deep along the superior border of the scapula above the supraspinatus muscle. At this point, a C-arm is utilized to take a posteroanterior view x-ray of the scapula. A hemostat or other radiopaque instrument can then be used to quickly localize the notch with fluoroscopy. Alternatively, a snap can be walked down the medial base of the coracoid process if there is poor visualization of the notch. The suprascapular ligament can then be sharply divided under direct vision with care to avoid the overlying artery and vein. The SSN can then be traced as proximally as possible for sharp division and neurotization.

POSTOPERATIVE MANAGEMENT

After the procedure, the patient is kept overnight for observation and pain control. The patient is discharged the following day with an arm sling. Occupational or physical therapy is initiated within 2 weeks to maintain passive range of motion and to start motor