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ORIGINAL COMMUNICATION

Posterior Approach Technique for Accessory-Suprascapular Nerve Transfer: A Cadaveric Study of the Anatomical Landmarks and Number of Myelinated Axons

D. PRUKSAKORN,[1*] K. SANANPANICH,[1] S. KHUNAMORNPONG,[2] S. PHUDHICHAREONRAT,[3] AND P. CHALIDAPONG[1]

[1]*Department of Orthopaedics, Faculty of Medicine, Chiang Mai University, Thailand*
[2]*Department of Pathology, Faculty of Medicine, Chiang Mai University, Thailand*
[3]*Department of Pathology, Prasat Neurological Institute, Bangkok, Thailand*

Accessory-suprascapular nerve transfer by the anterior supraclavicular approach technique was suggested to ensure transferrance of the spinal accessory nerve to healthy recipients. However, a double crush lesion of the suprascapular nerve might not be sufficiently demonstrated. In that case, accessory-suprascapular nerve transfer by the posterior approach would probably solve the problem. The aim of this study was to evaluate the anatomical landmarks and histomorphometry of the spinal accessory and suprascapular nerve in the posterior approach. Dissection of fresh cadaveric shoulder in a prone position identified the spinal accessory and suprascapular nerve by the trapezius muscle splitting technique. After that, nerves were taken for histomorphometric evaluation. The spinal accessory nerve was located approximately halfway between the spinous process and conoid tubercle. The average distance from the conoid tubercle to the suprascapular nerve (medial edge of the suprascapular notch) is 3.3 cm. The mean number of myelinated axons of the spinal accessory and suprascapular nerve was 1,603 and 6,004 axons, respectively. The results of this study supported the brachial plexus reconstructive surgeons, who carry out accessory-suprascapular nerve transfer by using the posterior approach technique. This technique is an alternative for patients who have severe crushed injury of the shoulder or suspected double crush lesion of the suprascapular nerve. Clin. Anat. 20:140–143, 2007.

Key words: brachial plexus injuries; spinal accessory nerve; nerve transfer; neurotization

INTRODUCTION

Accessory-suprascapular nerve transfer by the anterior supraclavicular approach technique for restoration of the shoulder function in brachial plexus injuries (BPI) has been commonly used. This surgical approach was described by various authors (Narakas, 1991; Chuang, 1995; Leffert, 1999; Hattori et al., 2001). However, a satisfactory outcome of this approach depends on whether the patient has

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*Correspondence to: Dr. Dumnoensun Pruksakorn, Department of Orthopaedics, Faculty of Medicine, Chiang-Mai University, Chiang-Mai, Thailand. E-mail: pdumnoen@mail.med.cmu.ac.th

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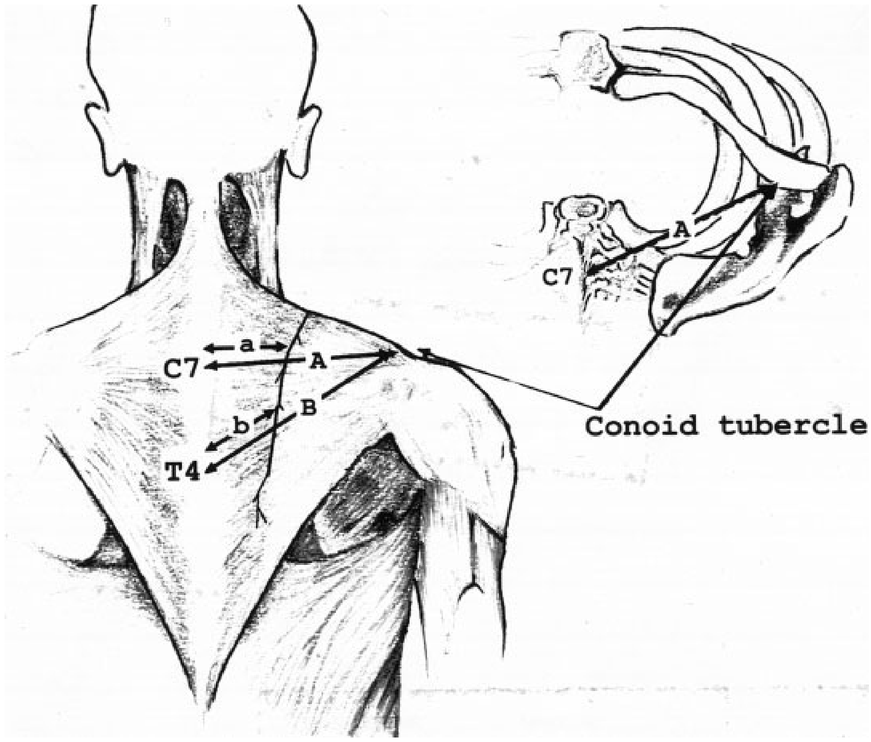

Fig. 1. Diagrammatic representation of the spinal accessory nerve, anatomical landmark, and the technique of measurement. SAN, spinal accessory nerve; A, the imaginary line A distance (tip of C7 spinous process to conoid tubercle); B, the imaginary line B distance (tip of T4 spinous process to conoid tubercle); a, tip of the C7-spinous process to spinal accessory nerve distance on line A; b, tip of the T4-spinous process to spinal accessory nerve distance on line B; a/A, spinal accessory distance ratio on line A; b/B, spinal accessory distance ratio on line B.

sustained a double crush lesion or not. Mikami et al. (1997) stated that powerful traction injuries of BPI patients may often damage the suprascapular nerve at several levels, such as the suprascapular notch and spinoglenoid notch region. For this reason, unpredictable results may occur when transferring the spinal accessory to the suprascapular nerve proximal to the lesion. Furthermore, patients with clavicle fracture and severe crush injury at the shoulder region frequently suffer from extended scar formation in the suprascapular nerve and adjacent tissues, thus causing difficulty in identifying this nerve in the scarred tissue.

The anterior supraclavicular approach technique was suggested to ensure transferrance of the spinal accessory nerve to healthy recipients. However, a double crush lesion of the suprascapular nerve might not be sufficiently demonstrated. The aforementioned approach limits the surgeon in transferring the spinal accessory nerve close to the motor unit of the supraspinatus muscle. In search of a better approach, we conducted this feasibility study to find a new technique for accessory-suprascapular nerve transfer. Many authors including Romeo et al. (1999) and Rengachary et al. (1979) have used the posterior approach for exploring the suprascapular nerve in suprascapular neuropathy patients. Furthermore, Jobe et al. (1996) described the position of the spinal accessory nerve in a trapezius-splitting approach in a cadaveric study. From these previous studies, it was possible for this study to identify the spinal accessory and suprascapular nerve by using the same incision as in the posterior approach. This incision might be an alternative surgical approach, which provides several advantages.

The primary aim of this study was to evaluate the anatomical landmarks of the spinal accessory nerve and suprascapular nerve in the posterior approach, and second, to determine the number of myelinated axons of both nerve trunks.

MATERIALS AND METHODS

This study was performed with a total of 41 shoulder girdles of fresh cadavers. Each cadaver was placed in a prone position. Identified is the C7-spinous process, which is the most prominent of anatomical surface at the lower neck area. The palpation was continued on the following spinous process to the T4-spinous process. An imaginary line A was created from the tip of the C7 spinous process to the conoid tubercle of the clavicle, and imaginary line B was created from the tip of the T4 spinous process to the conoid tubercle of the clavicle. The spinal accessory nerve was perpendicular to the imaginary lines and lying anterior to the trapezius muscle (Fig. 1). At lines A and B, the dissection of the trapezius muscle anteriorly showed the spinal accessory nerve. After measurement of the distance from the tip of the C7 and T4 spinous process to the spinal accessory nerve on lines A and B (a, b), a ratio compared to the distance of lines A and B was described (a/A, b/B).

The distance from the conoid tubercle to the most medial edge of the suprascapular notch on line A (*xy*) was measured (Fig. 2). Specimens from the spinal accessory nerve on line A and suprascapular nerve at the suprascapular notch were taken for histomorphometric evaluation. They were immediately immersed in formalin solution. Then, the specimens were cut to the histological section with an ultramicrotome (6 μm). The sections were stained by the Luxol fast blue (Kluver-Barrera) method for myelin and Masson's trichrome stain.

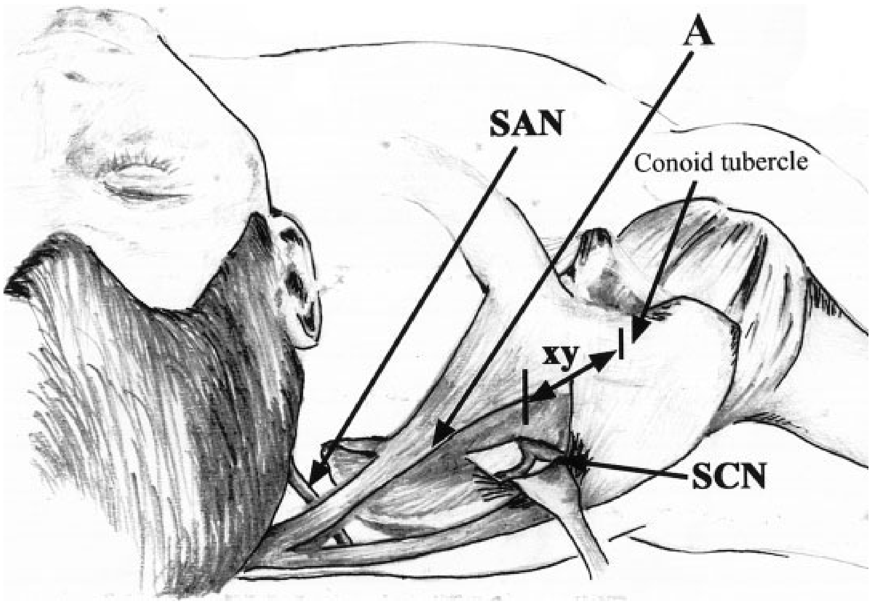

Fig. 2. Anatomy of the spinal accessory and suprascapular nerve by posterior approach (trapezius splitting technique along imaginary line A), and the distance from the conoid tubercle to the most medial edge of the suprascapular notch (*xy*). SAN, spinal accessory nerve; SCN, suprascapular nerve.

Cross sectional histologic pictures of the analyzed nerve were captured by using a light microscope (Olympus BX40), connected to a digital camera (Nikon Coolpix E222 with 1,200 × 1,600 pixels). The number of myelinated axons was counted with a computer assisted method. The 600× enlarged picture showed the myelinated axons that were counted in Luxol fast blue and Masson's trichrome stain.

RESULTS

Anatomical Evaluations

On line A, the average distance ratio of the spinal accessory nerve to the tip of the C7 spinous process was 0.53 ± 0.07.

On line B, the average distance ratio of the spinal accessory nerve to the tip of the T4 spinous process was 0.44 ± 0.08.

The average distance from conoid tubercle to the medial edge of suprascapular notch on line A was 3.3 ± 0.8 cm.

Histomorphometric Evaluations

The number of fascicles and myelinated axons of the spinal accessory nerve on line A and suprascapular nerve at the suprascapular notch is shown in Table 1.

DISCUSSION

The spinal accessory nerve was located approximately halfway along line A. The suprascapular nerve was located in the suprascapular notch ~3.3 cm just medial to the conoid tubercle of the clavicle, and beneath the supraspinatus muscle. Thus, the incision along line A could identify both nerves.

According to this study, incision of the posterior approach should start approximately halfway along line A and extend laterally, just medial to the conoid tubercle. Nerves were searched for by the trapezius muscle splitting technique.

The tip of the spinous process C7, T4 and conoid tubercle of the clavicular bone were chosen as body landmarks, because of their prominent surface anatomy and close proximity to the spinal accessory and suprascapular nerve. Effectively estimating the position of the spinal accessory nerve by the posterior approach in various patients' body sizes is a problem. The position of the shoulder also distorts the spinal accessory nerve from the body landmark. Jobe et al. (1996) revealed that the percentage method rather than the absolute distance was used not only because the muscle varies in size from person to person, but also because, with contraction, the same muscle may vary in dimension from moment to moment. It was hoped that a percentage would yield a narrow and therefore more useful band of data. This study modified his technique to decrease the confounder from the body size and position of the shoulder.

The posterior approach had several advantages such as transferring the spinal accessory nerve closer to the neuromuscular junction of the supraspinatus muscle. Furthermore, the infraclavicular lesion could be identified in the suspected double crush lesion (suprascapular notch region), and the most distal and healthy segment could be selected for nerve transfer. Finally, this technique was favorable for the cosmetic affect on the surgical scar.

The spinal accessory nerve was also located approximately halfway along line B. This position helps surgeons to realize the course of spinal accessory nerve along the tra-

TABLE 1. Number of Fascicles and Myelinated Axons of the Spinal Accessory and Suprascapular Nerve (mean ± sd, *n* = 41)

Nerve	Spinal accessory nerve	Suprascapular nerve
The mean number of fascicles	3.4 ± 1.1	12.0 ± 2.4
The mean number of myelinated axons	1,603 ± 415.5	6,004 ± 646.8

pezius muscle and emphasized surgeons to find out spinal accessory nerve intraoperatively. The risks of this approach involve damage to the suprascapular vessels, which usually cross over the suprascapular ligament.

A difficulty with the nerve transfer technique is finding a suitable donor nerve that can provide adequate regenerating axons for the recipient. Narakas (1991) transferred the spinal accessory nerve (1,700 myelinated axons), or two intercostal nerves (each 300–500 myelinated axons) to the musculocutaneous nerve (3,000 myelinated axons). Patients were subsequently capable of flexing the elbow through the musculocutaneous nerve with a force of M3 to M3+. Chuang (1995) reported that the suprascapular nerve was the good recipient for the spinal accessory nerve, with 45 degrees of shoulder abduction achieved. Songcharoen et al. (1996) reported satisfactory biceps recovery by transferring the spinal accessory nerve to the musculocutaneous nerve (14,004 $\pm$ 5,400 total fibers). Dailiana et al. (2001) revealed that several surgeons transferred the spinal accessory nerve (1,700 myelinated axons) to the recipient musculocutaneous nerve (6,000 myelinated axons).

In this study, the average number of myelinated axons of the spinal accessory nerve was 1,603. Although the dissection was located more distal from the anterior supraclavicular approach, the histomorphometric evaluation of the myelinated axon was similar to the donor nerves in previous reports. The number of myelinated axons of the suprascapular nerve around the suprascapular notch region, which is more distal to the site of operation in the standard supraclavicular approach, was 6,004. Bahm et al. (2005) reported 23 cases of the posterior approach for accessory-suprascapular nerve transfer, which provide several advantages including safe, the nerve repair is reliable, the reinnervation is rapid and the dorsal scar is short and acceptable in the selected case. These results supported brachial plexus reconstructive surgeons, who carry out accessory-suprascapular nerve transfer by the posterior approach technique. This technique is an alternative for patients who have severe crushed injury of the shoulder or suspected double crush lesion of the suprascapular nerve.

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