Nerve Transfers to Restore Shoulder Function

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KEYWORDS

• Brachial plexus injuries • Nerve injury • Nerve transfer • Shoulder function

KEY POINTS

- Spinal accessory nerve to suprascapular nerve transfer could restore some abduction, forward flexion, and possibly external rotation of the shoulder.
- Double nerve transfers to both suprascapular and axillary nerves, when adequate donors are available, provide better shoulder abduction than single nerve transfer does.
- The long head of the triceps branch to the anterior branch of the axillary nerve transfer via the posterior approach could restore good shoulder function.
- Serratus anterior is a major muscle stabilizer of the shoulder and should be reconstructed to achieve optimal shoulder function.
- Intercostal nerves could be used as donor nerves for transfer to the axillary nerve via a posterior approach or to the long thoracic nerve via an anterior approach.

INTRODUCTION

The shoulder girdle consists of 5 articulations, namely the glenohumeral, acromioclavicular, sternoclavicular, subacromial, and scapulothoracic. Complex movements of these articulations, as coordinated by the girdle musculature, allow accurate placement of the hand in time and space. Normal shoulder function is thus fundamental to normal prehensile function. Apart from the initial 30°, full shoulder abduction in the coronal plane is effected by simultaneous motion of both the glenohumeral joint and scapular rotation in the ratio of 2:1.[1] Normal scapular motion is controlled by 17 muscles that receive innervations from some 12 named peripheral nerves. Different injuries of the nerve supply to the musculature may thus result in a spectrum of functional deficits.

Paralysis of the deltoid and rotator cuff muscles is encountered commonly in patients with upper roots brachial plexus injury. In this group of patients, restoration of shoulder function is generally regarded as the second reconstructive priority after restoration of elbow flexion. To achieve better shoulder abduction, most surgeons now would recommend double nerve transfers to both suprascapular and axillary nerves when adequate donors are available.[2–4]

Serratus anterior is an essential scapular stabilizer. Injury to the long thoracic nerve or the upper brachial plexus roots may result in scapular winging and limitation of shoulder movement.

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As the stability of the scapula is fundamental for optimal shoulder function, reanimation of the paralyzed serratus anterior muscle is recommended.[5]

Isolated axillary nerve injury may occur after shoulder trauma or surgery.[6–8] In some patients with the nerve injury, normal shoulder range of motion is still possible provided the rotator cuff tendons and the suprascapular nerve are intact.[9] On clinical examination, these patients can be deceptively functional. However, without a functioning deltoid, the shoulder would fatigue easily.[10] With advancing age, there is a significant increase in the incidence of asymptomatic and symptomatic rotator cuff tears in those without deltoid function compared with those with functional deltoids.[11,12] It is thus generally accepted that isolated axillary nerve injury should be treated to avoid the potential risk of a future rotator cuff tear.[10]

In this article, we outline the various surgical techniques of nerve transfers to restore shoulder function and summarize the clinical results.

SURGICAL TECHNIQUES

Spinal Accessory Nerve to Suprascapular Nerve Transfer (Anterior Approach)

The spinal accessory nerve is a pure motor nerve, which innervates the sternocleidomastoid and trapezius muscles. When it is used as a donor nerve, it is important to isolate the distal branch while preserving the branches to the upper and middle trapezius to preserve some trapezius function. Interposition nerve graft is best avoided, because that would require 2 neurorrhaphy sites for a single transfer, thereby compromising the potential outcome.

The functional aim of this nerve transfer is to regain some abduction and forward flexion of the arm. External rotation of the shoulder may be restored to variable degrees and this can only be achieved when the scapula is stable.

Preoperative planning

Contraindications to this nerve transfer include trapezius muscle power of less than M4 or extensive injury of the supraclavicular area.

Preparation and patient positioning

The patient is placed in a supine position with a sandbag beneath the affected upper extremity. The head is turned to the contralateral side and the upper part of the body is elevated slightly to reduce venous congestion (relaxed beach chair position). Long-acting paralytic agents and muscle relaxants are avoided to allow intraoperative electrical stimulation.

Surgical approach and procedure

Our preferred exposure of the supraclavicular plexus is through a V-shaped incision. We use the lateral portion of the transverse limb, which lies 1 cm above and parallel to the clavicle, for exploration of the spinal accessory nerve. The lateral part of the trapezius is detached from the distal clavicle for 1 to 2 cm. Dissection is then performed on the anterior surface of the trapezius muscle several centimeters above the clavicle. The landmark for detecting the nerve is the transverse cervical vessels that accompany the nerve. An electrical stimulator can be used around the vessels to identify the distal part of the spinal accessory nerve. This nerve should not be confused with the small branches from the cervical plexus, which will not elicit any muscle response when stimulated. The spinal accessory nerve should be dissected as far distally as possible.

The suprascapular nerve is normally found arising from the upper trunk 2 to 3 cm above the clavicle. However, the nerve can be difficult to find after traction injury to the plexus. A technical tip is to ask the assistant to pull the patient's affected arm downward while the operator palpates with a finger for a tented structure on the most lateral aspect of the brachial plexus. This is then followed with further blunt finger dissection down to the scapular notch, where the integrity of the nerve is confirmed. The suprascapular nerve is then traced from distal to proximal and disconnected from the upper trunk before coaptation with the donor spinal accessory nerve (Fig. 1).

Postoperative care and rehabilitation

The patient's arm is placed in a sling for 3 weeks. Gentle passive mobilization is then performed to

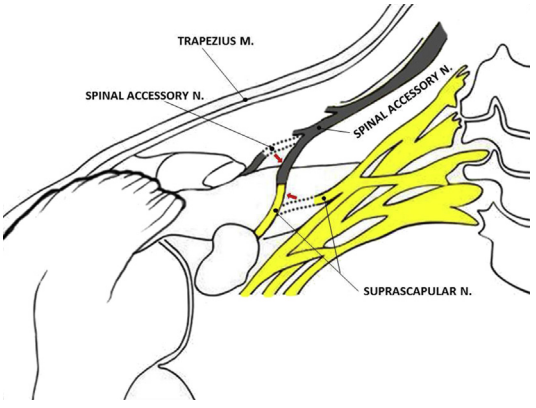

Fig. 1. Transfer of the spinal accessory nerve to the suprascapular nerve by anterior approach. M., muscle; N., nerve. (*Courtesy of* Kunakorn Lohagard, FA, Bangkok, Thailand.)