Contralateral Spinal Accessory Nerve Transfer: A New Technique in Panavulsive Brachial Plexus Palsy

Jaime Zermeño-Rivera · Bianca Ethel Gutiérrez-Amavizca

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Abstract Brachial plexus avulsion results from excessive stretching and can occur secondary to motor vehicle accidents, mainly in motorcyclists. In a 28-year-old man with panavulsive brachial plexus palsy, we describe an alternative technique to repair brachial plexus avulsion and to stabilize and preserve shoulder function by transferring the contralateral spinal accessory nerve to the suprascapular nerve. We observed positive clinical and electromyographic results in sternocleidomastoid, trapezius, supraspinatus, infraspinatus, pectoralis, triceps, and biceps, with good outcome and prognosis for shoulder function at 12 months after surgery. This technique provides a unique opportunity for patients suffering from severe brachial plexus injuries and lacking enough donor nerves to obtain shoulder stability and mobility while avoiding bone fusion and preserving functionality of the contralateral shoulder with favorable postoperative outcomes.

Keywords Brachial plexus · Neurolysis · Nerve transfer · Spinal accessory

Introduction

Adult brachial plexus injury is a devastating condition that usually affects young adults. It is mainly caused by vehicle or motorcycle accidents and has significant socioeconomic implications [1]. Brachial plexus avulsion occurs when the nerve is torn from its attachment (proximal avulsion is produced at spinal cord level, distal avulsion at the muscle level). To date, there are numerous surgical procedures for brachial plexus reconstruction and is one of the most difficult problems among the traumatic injuries of nerves [2]. Many techniques have described the use of different nerves as donor nerves for transfer to the suprascapular nerve with the aim of returning shoulder and elbow function, with varying results [1–5]. This report aims to present and describe a new, alternative technique to repair brachial plexus avulsion and stabilize the shoulder when there are not enough donor nerves.

Case Report

A 28-year-old man suffered from a motorcycle accident. He was healthy before the accident. He suffered traumatic brain injury with loss of consciousness for 1 week and had a fractured right clavicle, left radius, and left ulna; paralyzed right diaphragmatic muscle; and severe pain in the right arm; he was also positive for Horner's syndrome on the right side. The patient was seen in our clinic consult 5 months after the accident. Written informed consent for participation was obtained from the patient, according to the Declaration of Helsinki guiding biomedical research involving human subjects. At physical exploration, he presented with right panavulsive brachial plexus palsy and ipsilateral spinal accessory nerve affection; paralysis of the rhomboid muscles, serratus anterior, trapezius, and sternocleidomastoid; winged scapula; and flaccid paralysis of the right thoracic limb. Electromyography

J. Zermeño-Rivera
Servicio de Cirugía Reconstructiva del Instituto Jalisciense de
Cirugía Reconstructiva “Dr. José Guerrero Santos”, Federalismo
Norte 2022, Guadalupeana, 44220 Guadalajara, Jalisco, Mexico

B. E. Gutiérrez-Amavizca (✉)
División de Genética, Centro de Investigación Biomédica de
Occidente, IMSS; Doctorado en Genética Humana, Centro
Universitario de Ciencias de la Salud, Universidad de Guadalajara,
Sierra Mojada 800. Col. Independencia, 44340 Guadalajara, Jalisco,
Mexico
e-mail: ethel90210@gmail.com

J. Zermeño-Rivera
Vida íntegra, control de diabetes y obesidad, José María Heredia
2964, Col. Prados Providencia, C.P. 44670 Guadalajara, Jalisco,
Mexico

(EMG) revealed severe axonotmesis of the right brachial plexus without reinnervation. Magnetic resonance imaging of the cervical spine evidenced a right paravertebral hematoma from C5 to C7; posttraumatic myelomeningocele of C7, C8, and T1; and the absence of roots C5 to C6.

Surgical Procedure

The reconstructive scheme for this patient was planned in three surgical stages. At the first reconstructive stage (8 months after the injury), surgical exploration was performed on the supraclavicular and infraclavicular brachial plexi, finding only nerve roots in the infraclavicular region; the third, fourth, and fifth intercostal nerves were transferred to the musculocutaneous nerve.

At the second reconstructive stage (10 months after the injury), surgery achieved two goals: contralateral C7 transfer to the radial nerve and contralateral spinal nerve transfer to both affected suprascapular and spinal accessory nerves (Fig. 1). The antebrachial cutaneous nerve on the affected side was recollected as a graft; the contralateral spinal accessory nerve was dissected and distally sectioned at the second branch of the trapezius muscle (donor). Next, the injured spinal accessory and suprascapular nerves were prepared as receptors for the transferred contralateral spinal accessory nerve with interposition of a 50-cm cutaneous antebrachial

graft (Fig. 2). At the third reconstructive stage, a surgical procedure will be developed to strengthen elbow flexion.

Results

Follow-up and Assessment

The upper limb was immobilized across the chest with soft dressings for 3 weeks after surgery. Postsurgical physical therapy was initiated after 30 days. After surgery, reinnervation was evaluated clinically by assessing the progression of Tinel's sign in the contralateral spinal accessory nerve, which was positive at the left supraclavicular fossa level on day 21, the presternal region on day 36, the posterior triangle of the right neck on day 50, and the suprascapular and trapezius muscles on day 66. Contralateral C7 reached the radial nerve at the triceps muscle on day 85. During physical examination at 16 weeks after surgery, the patient was able to contract his pectoralis major and triceps in the gravity-eliminated plane, and an effect on shoulder stability was clearly visible when he performed the place and hold maneuver. EMG-triggered electrical stimulation was performed every 6 months to evaluate the condition of nerve regeneration of the affected side muscles demonstrated positive and polyphasic reinnervation waves at the sternocleidomastoid, trapezius,

Fig. 1 Contralateral spinal accessory nerve transfer: the first two stages of the reconstructive technique

Fig. 2 Transfer of the contralateral spinal accessory nerve to the affected suprascapular and spinal accessory nerves

supraspinatus, infraspinatus, pectoralis, triceps, and biceps. Motor function was examined at 12 months after the operation, according to the British Medical Research Council (MRC) on a scale ranging from 0 to 5 points. Grade 0 to 2 was defined as a poor recovery and 3 to 5 as a good recovery. Sternocleidomastoid muscle was MRC grade 3, trapezius MRC grade 4, supraspinatus, MRC grade 2, and infraspinatus MRC grade 2. Range of mobility for shoulder to date at 4 months following: 10° shoulder flexion, 15° shoulder abduction, 5° shoulder extension, 85° internal rotation, and 3° external rotation.

Discussion

Indications for contralateral C7 transfer in brachial plexus injury include: when there is a lack of available neurotizers in the affected side, when one is used in multiple neurotization in the context of total root avulsion injury, and when a neurotization fails in any type of avulsion injury [1–3]. As antecedent, Tubbs et al., in 2011, evaluated on cadaveric study of the spinal accessory nerve, as a potential donor nerve for contralateral nerve injuries, and concluded that the contralateral spinal accessory nerve might be considered for ipsilateral nerve transfer of the suprascapular and axillary nerves and radial nerve branches to the triceps brachii muscle [6], and in

2012, Felici et al. described in a group of six consecutive patients the clinical use of the contralateral spinal accessory nerve as a donor nerve for brachial plexus surgery, showing good results in terms of functional recovery [7].

We described a new technique in the context of panavulsive brachial plexus palsy. This technique consists of transfer of the contralateral spinal accessory nerve to the suprascapular nerve. We observed a positive result for shoulder function with good recovery in this patient at 12 months after surgery. However, it should be noted that this technique was performed on a subacute injury, and nerve reconstruction was not entirely optimal because it should ideally be performed within 3 months after trauma. In conclusion, this technique provides a unique opportunity for patients suffering from severe brachial plexus injuries and lacking enough donor nerves to obtain shoulder stability and mobility while avoiding bone fusion and preserving functionality of the contralateral shoulder. Transfer of the contralateral spinal accessory nerve to the suprascapular nerve has been a safe and effective technique with favorable postoperative outcomes. However, it requires meticulous dissection of the donor nerve and technical mastery to avoid damaging the healthy side.

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