

TECHNIQUE

Transfer of the Intercostal Nerves to the Nerve of the Long Head of the Triceps to Recover Elbow Extension in Brachial Plexus Palsy

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■ ABSTRACT

Restoration of elbow flexion is the first goal in brachial plexus injuries. The current procedures using nerve grafts and nerve transfers authorize more extensive repairs, with different possible targets: shoulder, elbow extension, and hand. Elbow extension is important to stabilize the elbow without the contralateral hand and allows achieving a useful grasp. The transfer of the intercostal nerves to the nerve of the long head of the triceps may restore this function in brachial plexus palsies. Furthermore, in case of C5 to C7 palsy, this transfer spares the radial nerve and gives a chance to spontaneous triceps recovery by the reinnervation from C8 root. Moreover, in case of absence or insufficient (M0 to M2 according to Medical Research Council scoring) recovery of elbow flexion strength by nerve surgery, the reinnervated triceps can be transferred. We present the technique of intercostal nerve transfer to the long head of the triceps branch to restore elbow extension in brachial plexus palsy. Results concerning 10 patients are presented.

Keywords: brachial plexus, intercostal nerve, triceps nerve, nerve transfer, elbow extension

■ HISTORICAL PERSPECTIVES

Nerve transfers are currently used in brachial plexus injuries with root avulsions. Suprascapular nerve, phrenic nerve, contralateral C7 root, partial median or ulnar nerves, and intercostal nerves are the more used donor nerves.^{1–4} However, concerning this last nerve transfer, the first publication did not report satisfactory results. In these series, the intercostal nerve transfer to the musculocutaneous nerve was performed with an

intercalated graft.⁵ However, in the last series, intercostal nerve transfers to the musculocutaneous nerve without intercalated nerve graft were reported with satisfactory results in restoration of elbow flexion.^{6–8} As a matter of fact, active elbow flexion is the first goal of upper limb function restoration in brachial plexus palsy. However, active extension is important to stabilize the elbow without the contralateral hand and to achieve a useful grasp. Therefore, the technique of intercostal nerve transfer may be used to restore elbow extension. Three intercostal nerves are coapted to the branch for the long head of the triceps muscle. The radial nerve is preserved to keep a possible spontaneous reinnervation of the lateral and medial head of the triceps muscle from the C8 root. We present the technique of the intercostal nerve transfer to the long head of the triceps branch to recover active elbow extension. Results concerning 10 patients are presented.

■ TECHNIQUE

A continuous thoraco-brachial incision is performed with an axillary Z-plasty. The thoracic part of the incision starts at the midline of the sternum on the fifth intercostal space. The incision follows the curve of the inferior border of the pectoralis major muscle until the axilla. Then, the incision is performed on the medial aspect of the arm (on the neurovascular pedicle level). The pectoralis major and minor are reflected from the second to the sixth ribs (Fig. 1).

The periosteum of the third to fifth ribs is incised from the costochondral junction anteriorly to the mid axillary line posteriorly. The intercostal nerves are exposed by using a subperiosteal approach (Fig. 2). The periosteum is reflected, and intercostal pedicles are exposed. One must take care of always keeping contact with the costal bone to avoid any pleural punctures or a breach in the muscular fascia. The periosteum is then dissected until the highest point possible on the under surface of the rib. The periosteum is detached and

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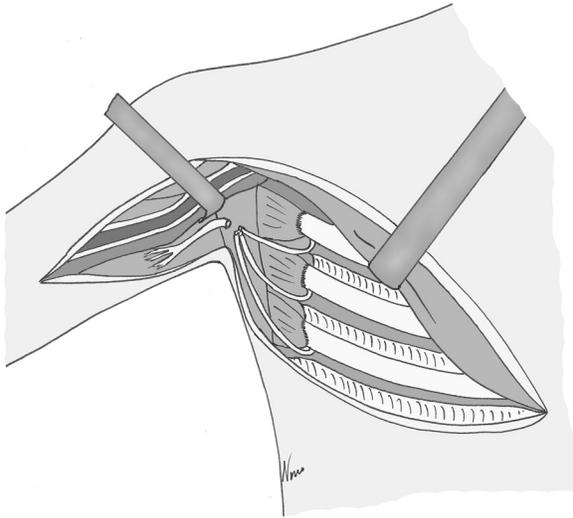


FIGURE 1. The brachial plexus has to be retracted to expose the nerve of the long head of the triceps. The pectoralis major and minor have to be reclinated to expose the intercostal spaces. The suture between 3 intercostal nerves and the nerve of the long head of the triceps is performed in the axillary.

pulled downward to expose its posterior aspect. The fascia is then incised, and the thin motor branch of the intercostal nerves is identified. Electrical stimulation may help to identify the motor intercostal nerve; the split sensory branch is left inside. This approach avoids bleeding secondary to the dissection through the large anterior intercostal muscles.

The radial nerve is located through the brachial and axillary approach. It is isolated in the posterior area of the brachial canal, generally behind the brachial vein.

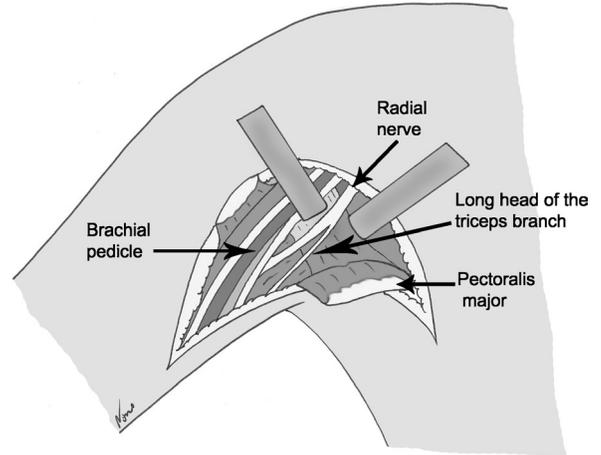


FIGURE 3. The branch of the long head of the triceps is found just behind the brachial plexus on the teres major and latissimus dorsi tendons. The tendon of the pectoralis major can be divided to facilitate the exposition. It must be sutured at the end of the procedure.

The pectoralis major tendon can be partially or totally divided to facilitate the dissection. The nerve of the long head of the triceps is found at the latissimus dorsi and teres major tendons level (Fig. 3). The long head triceps branch is traced onto the radial nerve to increase its length to facilitate the direct suture with the intercostal nerves. After this splitting, the long head triceps branch is divided proximally. The intercostal nerve extremities are prepared and glued together. A clean section of the distal extremity is performed. Then, the microsurgical anastomosis is performed between the intercostal nerves and the nerve to the long head of triceps using 11/0 nylon sutures with the arm in full abduction. The size of 3

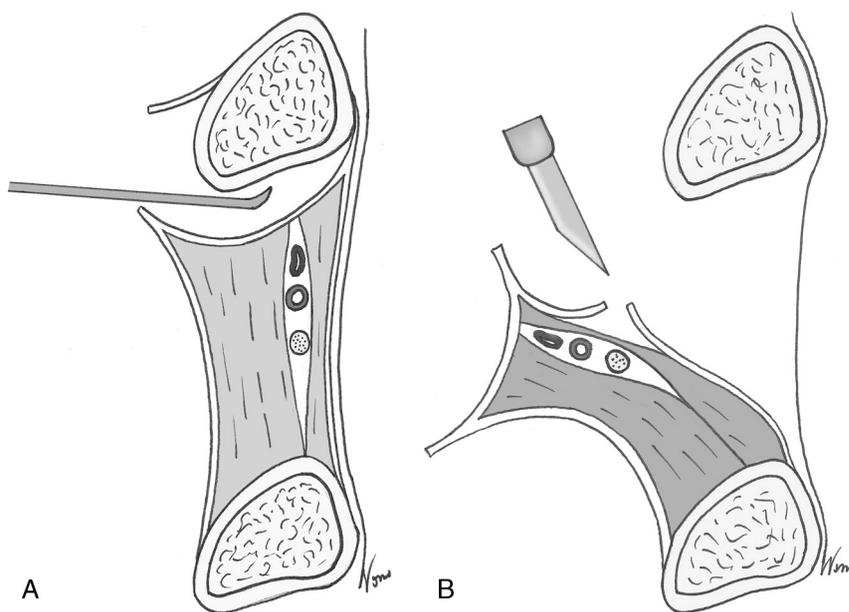


FIGURE 2. A, Principles of the subperiosteal approach of the intercostal nerves. The costal periosteum is incised and detached from the inferior aspect of the rib until its posterior margin. One must take care of the pleural fascia by always keeping the contact between the raspator and the bone. B, The periosteal flap containing the intercostal pedicle is pulled downward and incised on its deeper aspect. Deep intercostal muscles are thinner, and the intercostal nerve may be isolated without bleeding.

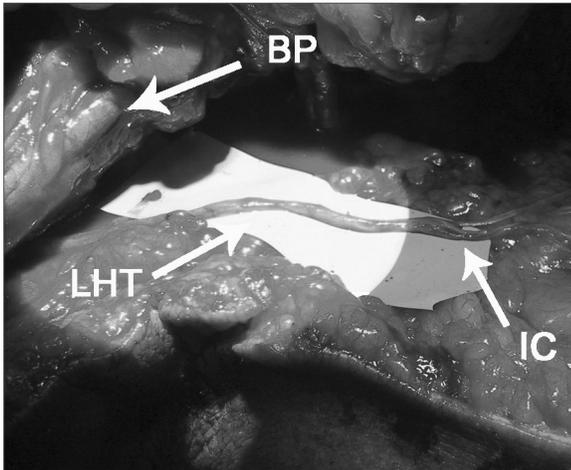


FIGURE 4. Direct suture between the nerve of the long head of the triceps and the 3 intercostal nerves: the sizes match perfectly. BP indicates brachial plexus; IC, intercostal nerve; LHT, nerve of the long head of the triceps.

intercostal nerves matches perfectly with the long head of the triceps branch (Fig. 4). Then, the pectoralis major tendon is sutured and skin is closed without suction drain to avoid injury of the nerve graft.

■ INDICATION/CONTRAINDICATIONS

Deficit of active elbow extension in total (C5 to T1) or partial (C5 to C7) brachial plexus palsy is the main indication of this nerve transfer. Moreover, this nerve transfer may be performed in cases of failure of nerve graft technique to the lateral trunk or musculocutaneous nerve. The reinnervated triceps may be used as palliative transfer to restore the elbow flexion.

However, intercostal nerves must be preserved to perform this transfer. Therefore, thoracotomy scars, rib fractures, or history of thoracic suction drain must be identified before the operation.

■ REHABILITATION

Postoperatively, the entire upper extremity is placed in a thoracobrachial immobilization with the elbow held in 90 degrees of flexion for a period of 3 weeks. The splint is then removed, and passive range-of-motion exercises of the elbow are encouraged for a period of 3 weeks. At 6 weeks, the patient starts physiotherapy to prevent joint contractures. As soon as the first contraction of the long head of the triceps muscle is identified, the patient is asked to breathe deeply until he or she recovers active

extension of the elbow against gravity. Then, strength exercises are initiated.

■ RESULTS

Three patients with C5 to C7 brachial plexus palsy and 7 patients with total brachial plexus palsy underwent this procedure. The average age was 25 years (range, 20–31 years). The average time before operation was 4 months (range, 3–9 months). Transfer of 3 intercostal nerves to the long head of the triceps branch was performed in all patients. No complications were noted, especially pneumothorax or hematoma.

The average follow-up was 23 months (range, 19–30 months). Seven patients scored M4 elbow extension according to Medical Research Council scoring. The average weight they can lift in with elbow extension was 3 kg (range, 1–4 kg). One patient recovered M3, and 2 patients had poor results with M1 and M2 elbow extension. The average time to recover first long head triceps contractions during deep inspiration was 7 months (range, 5–9 months). The average time to recover extension against resistance was 15 months (range, 13–19 months).

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