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HANSUR-238; No. of Pages 6
ARTICLE IN PRESS
Hand Surgery and Rehabilitation xxx (2018) xxx–xxx

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Original article

Postoperative motor deficits following elbow flexion reanimation by nerve transfer☆

Déficits moteurs postopératoires après transfert nerveux de réanimation de la flexion du coude

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ARTICLE INFO

Article history:
Received 23 May 2018
Received in revised form 6 July 2018
Accepted 11 July 2018
Available online xxx

Keywords:
Anterior interosseous nerve
Brachial plexus
Elbow flexion
Nerve transfer
Oberlin's procedure
Postoperative deficit

ABSTRACT

We aimed to assess the rate and type of postoperative motor deficits that might be encountered following elbow flexion reanimation using ulnar- and/or median-based side-to-end nerve transfers in patients with brachial plexus injuries. All patients who underwent elbow flexion reanimation between November 2015 and October 2017 at our facility by nerve transfer based on partial harvests of the median and/or ulnar nerves were included. Postoperative clinical assessment was conducted the day after surgery to identify motor deficits in the territory of the harvested nerves. If a clinically noticeable deficit was present, the type and extent of the deficit were noted, and postoperative clinical evaluations were conducted monthly to determine its progression. After reviewing the charts of 27 consecutive patients, 4 patients were found to have a postoperative motor deficit (15%). In all four cases, the deficit was limited to the anterior interosseous nerve (AIN) territory in patients who underwent a double transfer (i.e., ulnar-to-biceps and median-to-brachialis). With clinical impairments of the flexor pollicis longus and/or the flexor digitorum profundus of the index and third fingers initially ranging from grade-0 to grade-3 strength, full recovery to preoperative strength levels occurred in all cases after a mean of 7 months' follow-up. Transient motor deficits may be observed in the AIN territory following elbow flexion reanimation when a median-to-brachialis nerve transfer is associated with the original Oberlin procedure.

Mots clés :
Nerf interosseux antérieur
Plexus brachial
Flexion du coude
Transfert nerveux
Technique d'Oberlin
Déficit postopératoire

RÉSUMÉ

Notre but était d'évaluer l'incidence, le type et l'évolution des déficits moteurs postopératoires dans les territoires des nerfs ulnaire et/ou médian pouvant être observés à la suite de transferts nerveux latéro-terminaux réalisés pour réanimer la flexion du coude. Tous les patients souffrant d'une paralysie de la flexion du coude ayant bénéficié de transferts nerveux partiels de nerf médian et/ou ulnaire dans notre service entre novembre 2015 et octobre 2017 furent inclus. Une évaluation clinique était réalisée le lendemain de l'intervention à la recherche de déficits moteurs dans les territoires des nerfs prélevés. En cas de déficit cliniquement identifiable, le type et l'étendue du déficit initial était notée, et un suivi mensuel était instauré afin d'en apprécier l'évolution. Les dossiers de 27 patients consécutifs furent analysés, dont ceux de 4 patients présentant un déficit moteur postopératoire (15 %). Dans ces quatre cas, il s'agissait d'un déficit limité au territoire du nerf interosseux antérieur (NIOA) chez des patients ayant bénéficié d'un double transfert (i.e., ulnaire-biceps brachialis et médian-brachialis). Avec une force

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https://doi.org/10.1016/j.hansur.2018.07.004
2468-1229/

Please cite this article in press as: Le Hanneur M, et al. Postoperative motor deficits following elbow flexion reanimation by nerve transfer. Hand Surg Rehab (2018), https://doi.org/10.1016/j.hansur.2018.07.004

postopératoire immédiate évaluée entre 0 et 3 sur 5 au niveau du flexor pollicis longus et/ou du flexor digitorum profundus des 2e et 3e doigts, tous les patients récupérèrent leur force préopératoire après un délai moyen de 7 mois. Lors de la réanimation de la flexion du coude par transfert nerveux, des déficits moteurs transitoires peuvent être observés dans le territoire du NIOA en cas de transfert médian-brachialis.

1. Introduction

There is currently a shift in brachial plexus injury (BPI) management in using surgery to address motor deficits [1]. Originally, grafting of nerves from intact cervical root stumps to primary functional targets were recommended in cases of post-ganglionic lesions, and palliative surgery was considered as the only viable option in cases of avulsion injuries [2]. However, since the initial description of a nerve transfer being performed to reanimate elbow flexion in 1994 [3], this alternative has become increasingly popular among the surgical community [4].

Depending on the type of harvest, nerve transfers may be divided in two categories: either a distal motor branch of a functioning muscle is harvested in its entirety (i.e., end-to-end transfer), or motor fascicles from a proximal composite nerve are selected with intraoperative neurostimulation (i.e., side-to-end transfer). They are sutured end-to-end to the affected target in both cases (i.e., end-to-end fascicular sutures) [5]. While postoperative deficits are inevitable in the territory of the selected branch in end-to-end transfers, most authors consider that the plexiform nature of proximal nerves seems to circumvent such shortcomings in side-to-end transfers [3,6,7].

For elbow flexion, Oberlin et al. described the first side-to-end transfer in upper BPI in which the ulnar nerve was partially harvested and transferred to the biceps brachii motor branch [3]. In 2006, they recommended performing an additional side-to-end transfer to improve the chances of recovery using motor fascicles from the median nerve to reinnervate the brachialis muscle [8]. Since then, numerous teams have reported highly satisfactory outcomes with both techniques [6–15]. However, very little information exists in the literature on postoperative deficits in the territories of the harvested nerves.

The objective of this study was to assess the rate and the type of postoperative motor deficits that may occur following elbow flexion reanimation using nerve transfer and to describe their evolution and management.

2. Patients and methods

2.1. Population

Between November 2015 and October 2017, all patients who underwent elbow flexion reanimation using nerve transfer based on the median and ulnar nerves were included. Preoperative physical examination focused on defining the type and extent of the palsy and determining the available therapeutic options; motor function assessment was conducted with the British Medical Research Council (BMRC) grading system [16]. An electrodiagnostic study was conducted preoperatively in all patients to rule out electrical reinnervation signs in the targeted muscles (i.e., biceps brachii and brachialis muscles).

2.2. Surgical technique and postoperative care

All patients were operated on by the last author (TL), using surgical techniques previously described in the literature [3,5,17,18]. Our strategy was primarily to reanimate both elbow flexors by performing ulnar-to-biceps and median-to-brachialis (UBMB) double nerve transfers. In cases of a positive response from one of the two elbow flexors to intraoperative neurostimulation, a single transfer was conducted toward the unresponsive muscle, ulnar-based, in order to increase the chances of elbow flexion recovery.

The patient was placed supine, with their upper limb draped free and abducted 90° from the torso. An incision was made on the medial aspect of the proximal half of the arm to open the humeral canal. The musculocutaneous nerve was identified proximally and dissected distally to separate the lateral antebrachial cutaneous nerve from the two motor branches—to the biceps muscle proximally and to the brachialis muscle distally. Once the perineurium was opened longitudinally with a No. 15 scalpel blade under microscope magnification, fascicular dissection was performed using microsurgical instruments, including non-toothed forceps and smooth-tip curved scissors. The fascicles were gradually separated from one another using the scissors while putting gentle axial traction on the fascicular epineurium with the forceps to preserve the vasa nervorum. Intraoperative neurostimulation (Vari-Stim®, Medtronic, Minneapolis, MN, USA) of each musculocutaneous motor branch was then used to confirm complete palsy of both muscles before any harvesting was carried out. The ulnar nerve was then identified and intraneural dissection was performed similarly at the level of the biceps brachii motor branch. Redundant fascicles to the flexor carpi ulnaris (FCU) were selected using electrical stimulation, whereas fascicles to the flexor digitorum profundus (FDP) and intrinsic muscles of the hand were preserved. The median nerve was then dissected to identify motor fascicles to the pronator teres (PT) and/or the palmaris longus (PL) at the level of the brachialis motor branch. If the response to intraoperative neurostimulation of the ulnar nerve fascicles was unsatisfactory (i.e., C5-C8 palsy), a second harvest from the median nerve was made proximally, at the level of biceps brachii motor branch (MBMB), while selecting fascicles to the flexor carpi radialis. Fascicular groups from the donor nerves were selected so their diameter was similar to the targeted musculocutaneous nerve branches. Harvested fascicles were then brought together flush with the motor branches to the biceps brachii and/or the brachialis muscles, sutured without tension with non-absorbable monofilament 9-0 nylon sutures (Ethilon, Ethicon, Sommerville, NJ, USA) and coated with fibrin-based bio-glue (Tisseel™, Baxter, Deerfield, IL, USA). Hemostasis was achieved using bipolar electrocautery prior to layer-by-layer subcuticular wound closure without a drain.

Postoperatively, the patient was placed in a resting sling for three weeks. Rehabilitation started when the sling was removed with elbow passive mobilization until active function was obtained. The day after surgery, a physical examination was performed by the operating surgeon to look for postoperative motor deficits in the territory of the harvested nerves. In cases of immediate clinical deficits, muscle strength was assessed monthly using the BMRC scale. The examinations were repeated monthly within the first year following the surgery to determine the time frame of clinical elbow flexion recovery.

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