Injury xxx (xxxx) xxx

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

A novel nerve transfer: The first palmar interosseous motor branch of the ulnar nerve to the recurrent motor branch of the median nerve☆

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ARTICLE INFO

Article history:
Accepted 21 February 2020
Available online xxx

Keywords:
Nerve transfer
Opposition
Pinch
Thenar atrophy

ABSTRACT

Introduction: The recovery of recurrent motor branch of the median nerve might be delayed in high level median nerve injuries due to the long reinnervation distance. The aim of this study is to define a novel nerve transfer to restore the opposition and pinch.

Methods: Two fresh frozen hand cadavers were used for the study. The motor branch of the first palmar interosseous muscle of the ulnar nerve was identified and dissected. Thenar branch of the median nerve was dissected from its insertion site. The motor branch of the first palmar interosseous muscle of the ulnar nerve was transferred to the thenar motor branch of the median nerve. Axon counts were examined histopathologically. Clinically this nerve transfer was performed for two female patients with a high-level median nerve injury. Mehta opposition scores were 21 and 20, respectively and the results were satisfactory six months after the surgery.

Discussion: Although exploration and repair are recommended as the first treatment for median nerve injuries, the waiting time until the motor branch is reinnervated is critical in high level lesions. Nerve transfers become very important for fast recovery.

Conclusions: This new nerve transfer proposal may be an important step in nerve transfer surgery.

Introduction

The median nerve provides innervation for important functional movements like the wrist, index, and middle finger flexion as well as pronation, opposition, and pinch. Especially precision pinch between the thumb and index finger requires coordinated movements of these digits for reliable task performance ensuring a fine grip. Flexion can be compensated by partial innervation of the ulnar nerve in a median nerve injury, whereas pinch strength is usually lost [1,2]. Pinch force and opposition restoration are rarely stated in the literature.

In high level median nerve injury and unrepairable, consequently grafted lesions, the recovery of the recurrent motor branch might be delayed, even not occur due to long distance. Therefore, regeneration of the thenar muscle is unpredictable. Even in primary repair, if expected spontaneous recovery time is thought to be achieved after the closing of motor endplates, nerve transfers are indicated [2]. In these cases, early restoration of the opposition and pinch strength can reduce the loss of hand function and improve quality of life.

Restoration of the opposition can be realized with tendon transfers, but this may cause some functional limitations for the thumb. In this instance, reinnervation of the opposing muscle may be considered. Although nerve transfers have become routine procedures nowadays, opposition and pinch force restoration are rarely mentioned in the literature.

The aim of this study is to investigate the clinical feasibility of transferring the first palmar interosseous muscle motor branch to the recurrent motor branch of the median nerve to restore opposition and pinch force. Regional ethics committee approval was obtained for this study.

☆ This paper is part of a Supplement supported by the European Federation of Societies of Microsurgery (EFSM).

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https://doi.org/10.1016/j.injury.2020.02.119
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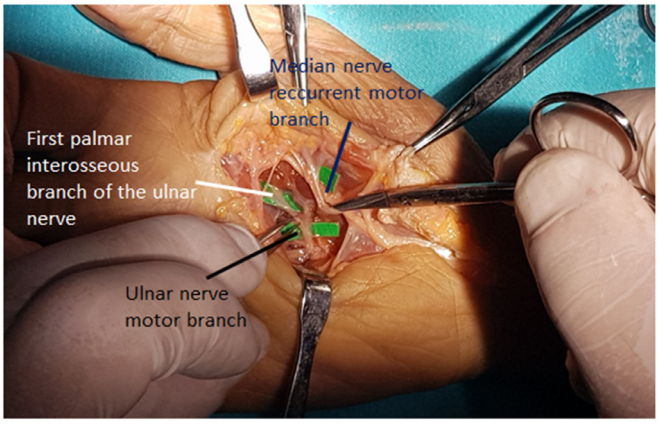

Fig. 1. The ulnar nerve motor branch to the first palmar interosseous and thenar branch of the median nerve from the same incision was dissected.

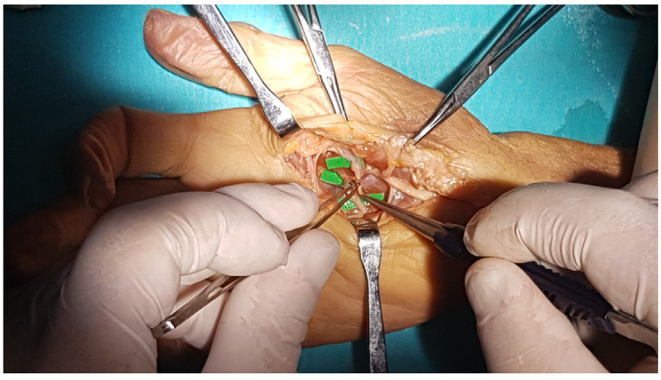

Fig. 2. Median nerve and ulnar nerve motor branches could be assembled without tension.

Methods

Cadaver study

Two fresh frozen hand cadavers were used. Dissections were performed under 2.5x magnifying surgical loupe. Each dissection was started by an incision over the thenar crease. The last branch of the ulnar nerve was dissected to preserve the terminal branch to the interosseous muscles. The motor branch of the first palmar interosseous muscle of the ulnar nerve was identified and dissected. Thenar branch of the median nerve was dissected from its insertion site (Fig. 1). It was observed that these two motor branches could be anastomosed without tension (Fig. 2). The diameters of the two nerves were compatible with each other. Small pieces from two nerves stumps were taken for pathologic examination. Axon counts of the motor branch of the first palmar interosseous muscle of the ulnar nerve and the recurrent motor branch of the median nerve were visualized under microscope magnification (Olympus BX50, Olympus Corporation, Tokyo, Japan) and identified with the Masson's trichrome stain. The axons were counted manually and determined as 385 and 636, respectively (Fig. 3).

Clinical cases

Two female patients (13 and 48-year-old) presented with high median nerve injury above elbow level following gunshot injuries without any additional injury or tissue defect. The median nerves were grafted, and at the same time the motor branch of the first palmar interosseous muscle of the ulnar nerve was transferred to

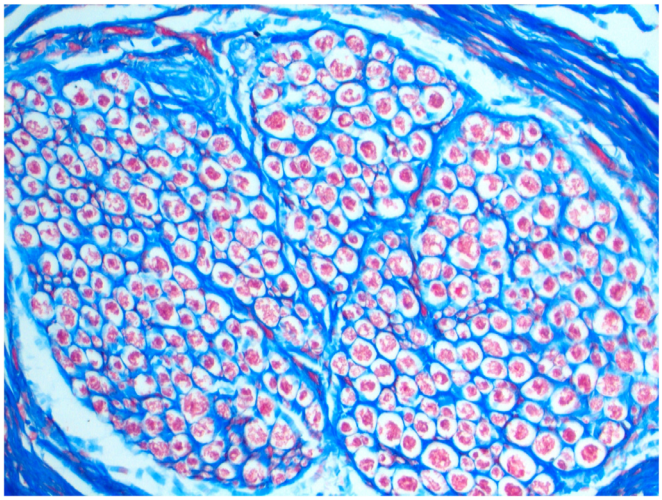

Fig. 3. Microscopical view of the axons with red stain inside the perineurium under x400 magnification. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

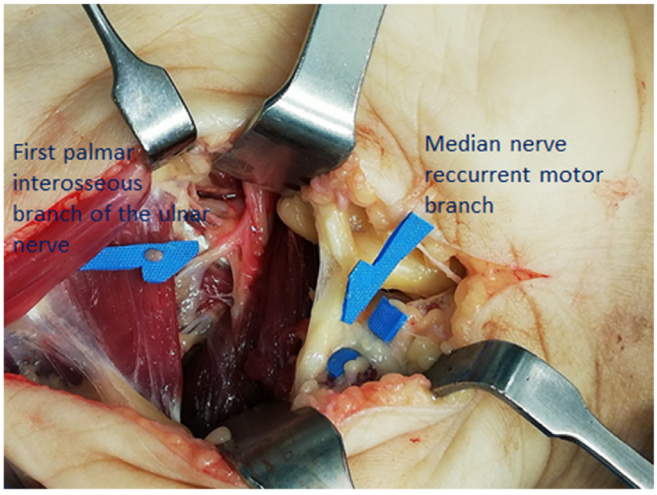

Fig. 4. 48-year-old female patient, ulnar nerve motor branch to the first palmar interosseous was transferred to the recurrent motor branch of the median nerve.

the recurrent motor nerve of the median nerve for both patients (Fig. 4). Both transfers were end-to-end. Surgical procedures were very easy. Because of the anatomical proximity closeness of the two nerves there was no need for meticulous dissection of the nerves proximally (Video). Clinical results were evaluated according to the scoring system defined by Mehta et al. (Position of thumb at rest, range of active palmar abduction of thumb, position of phalanx at rest and on pinching, pinch pattern, and pinch strength) [3]. At postoperative sixth month the opposition scores were 21 and 20, respectively and the patients had no fixed abduction of the index finger (Fig. 5). The loss of adduction was not consciously distinguished by the patients. The satisfaction was very high for both patients.

Discussion

Although exploration and repair are recommended as the first treatment for median nerve injuries, in high level lesions, the waiting time until the motor branch is reinnervated is critical. Therefore, it seems reasonable to carry out a nerve transfer to thenar muscles before motor endplate degeneration [4]. Nerve transfers

Please cite this article as: I.B. Ozcelik, G. Yildiran and B. Mersa et al., A novel nerve transfer: The first palmar interosseous motor branch of the ulnar nerve to the recurrent motor branch of the median nerve, Injury, https://doi.org/10.1016/j.injury.2020.02.119

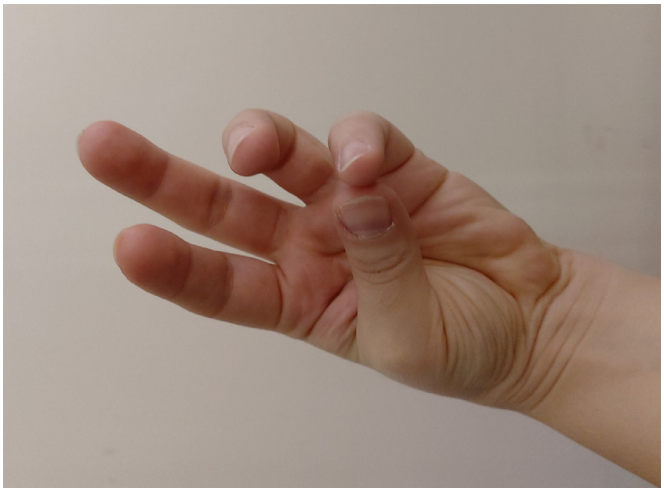

Fig. 5. Opposition at postoperative 6th months.

have been developed recently, and new techniques have been introduced for various nerve injuries. However, the feasibility of clinical applications should be demonstrated with cadaver studies.

Anatomically hypothenar muscles, interosseous muscles, adductor pollicis, flexor pollicis brevis, and ulnar two lumbricals are innervated by the motor branches of the ulnar nerve. The palmar muscles provide finger adduction, whereas the dorsal muscles provide abduction. All the muscles are innervated by the deep ulnar branch of the ulnar nerve [5]. The first palmar interossei is placed between the second and third metacarpal. As originating from the medial side of the second metacarpal its function is the adduction of the index finger.

The recurrent thenar motor branch innervates the abductor pollicis brevis, opponens pollicis, and the superficial head of the flexor pollicis brevis; which provide the opposition and pinch movement [6]. Restoring the motor function of the thenar muscles is difficult and in the case of high median nerve injuries rarely leads to satisfactory results [7]. Historically, tendon transfer (opponensplasty) has been the gold standard, with extensor indicis proprius as the most commonly used donor [7]. Normal strength and opposition are typically not achieved with these transfers which could cause also some complications like index finger metacarpophalangeal (MCP) joint contracture [8]. Due to similar problems arising in tendon transfers, nerve transfers became to the forefront and they gained validity and popularity to reinnervate the muscles that need to do their own original movement.

Nerve transfers are rarely used for opposition and pinch movements. The unique nerve transfer study in the literature for reinnervation of the thenar musculature was published by Bertelli et al. They have transferred the abductor digiti minimi muscle branch to the thenar branch and showed the results anatomically and clinically [2]. This transfer could result in loss of abduction in the fifth finger. In our study, the first palmar interosseous muscle motor branch of the ulnar nerve was transferred in the second web space. An important advantage of this technique is the convenience of dissection of both the ulnar nerve donor motor branch and the motor branches of the median nerve from a single thenar incision. We think that the loss of index finger adduction is negligible. The patients never complained about it. Nevertheless, for smokers the adduction of the index finger could be important. In such a case the first palmar interosseus muscle motor nerve providing the ring finger adduction could be used. The distance between two nerve ends will be far but still reachable. More proximal dissection of the thenar motor branch is needed to assure a tension-free anastomosis. Another advantage is the preservation of adductor pollicis muscle which with opponens pollicis are essentials in precision pinch and opposition [9].

As general principles of motor nerve transfers, the donor nerve should be located near motor endplates of the target muscle, should be a pure motor nerve, and sacrificable [10,11]. The first palmar interosseous muscle motor branch of the ulnar nerve is close to the thenar muscles, is a pure motor branch, and is relatively expendable conforming to the general principles.

The diameters of the recurrent motor branch of the median nerve and the first palmar interosseous muscle branch of the ulnar nerve were macroscopically congruent. Also, the axon numbers of both nerves were compatible. Therefore, there was no need for interfascicular dissection and neurorrhaphy.

Even though the target muscle is very conveniently situated for the anastomosis site, the recovery of the function could take three to six months. Perhaps this is due to the cognitive adaptation difficulty and reinforcement of the atrophic muscle period. The lack of the statistically sufficient number of clinical cases is the main limitation of this study. Increasing the cadaver number could show possible anatomic variations. This study could be rated as a spadework of the nerve transfer restoring the opposition.

Conclusions

Reinnervation of the thenar muscles and recovery of opposition and pinch strength is very important for sufficient hand function. We believe that this new nerve transfer proposal will be an important step in nerve transfer surgery.

Disclosure

None of the authors have any financial and personal relationships with other people or organizations that could inappropriately influence (bias) their work.

Declaration of Competing Interest

None.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.injury.2020.02.119.

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