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Case report

End-to-side innervated sensate radial forearm flap in the hand: A 5-year follow-up

Lambeau radial de l'avant-bras réinnervé en termino-latéral à la main : suivi de 5 ans

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ABSTRACT

Optimal functional reconstruction of the palmar surface of the hand requires good sensibility especially for the thumb and the radial side of the fingers. We report the long-term results of a distally based radial forearm flap (RFF) used for soft tissue coverage in the palm, index and middle finger and an end-to-side neurotaphy between the lateral antebrachial cutaneous nerve (LACN) and the proper palmar digital nerve of the middle finger to restore sensation. At 5 years' follow-up, the patient's sensory recovery was assessed through static and moving two-point discrimination, light touch sensation, pain perception, hot and cold temperature perception, an electrophysiological study and sweat test. An S3+ sensory recovery on the British Medical Research Council scale, as modified by Mackinnon and Dellon, was noted together with a good perception in the palm compared to decreased perception in the volar surface of the proximal phalanx. These findings prove that the RFF can provide good functional coverage of the palm together with good sensitivity by end-to-side reinnervation.

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R É S U M É

La reconstruction fonctionnelle optimale de la surface palmaire de la main nécessite une bonne sensibilité, en particulier pour le pouce et le côté radial des doigts. Nous rapportons les résultats à long terme d'un lambeau antébrachial radial à pédicule distal (LARPD) utilisé pour la couverture de la paume et de la face palmaire des 2^{ème} et 3^{ème} rayons pour restaurer la sensibilité par neurographie termino-latérale entre le nerf cutané latéral de l'avant-bras et le nerf digital palmaire propre radial du majeur. À 5 ans de suivi, la récupération sensitive a été évaluée cliniquement et électriquement. Une récupération sensorielle S3+ à l'échelle du British Medical Research Council, telle que modifiée par Mackinnon et Dellon, était associée à une bonne perception de la paume par rapport à une diminution de la perception de la surface palmaire de la phalange proximale, prouvant que le LARPD peut fournir une bonne couverture fonctionnelle de la paume avec une bonne sensibilité par une réinnervation en termino-latérale.

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1. Introduction

In classic plastic and reconstructive surgery, functional reconstruction of the palmar surface is best achieved by obtaining

stable primary soft tissue coverage. Other requirements for soft tissue coverage on the dominant side of the hand are a relative immobile (for mechanical stability) and sensate hairless skin, with good texture, color match and thin pliable texture [1]. Restoring sensibility is a high priority while providing soft tissue coverage for the thumb and the radial side of the fingers [2].

Previous reports have described a sensate radial forearm flap using the lateral antebrachial cutaneous nerve (LACN) sutured

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“end-to-end” with a digital nerve [3] or in an “end-to-side” fashion, especially in oral reconstruction [4]. Here, we describe a distally based radial forearm flap used to provide soft tissue coverage in the palm and to restore sensibility through an “end-to-side” neuroorrhaphy and report the long-term results.

2. Case report

A fit 43-year-old right-handed male was admitted with a complex lesion on the volar side of the palm, index and middle finger, caused by a carding machine (Fig. 1A). In the first-stage procedure, two silicone rods were placed – one in each injured finger – to reconstruct the flexor digitorum profundus (FDP) tendons and a nerve graft from the medial antebrachial cutaneous nerve (MACN) was used to reconstruct the radial palmar proper digital nerve of the index finger, bridging a gap of 2.5 cm. The ulnar non-dominant proper palmar digital nerve of the middle finger was harvested distal to the bifurcation of the common palmar digital nerve and used as a graft to reconstruct the severed dominant radial palmar proper digital nerve of the same finger. A classic, non-sensate, distally based reverse radial forearm flap was harvested to cover a 7 x 3 cm palmar skin defect of the index and middle fingers, creating a transient syndactyly.

The second stage of surgery was performed 3 months later. The syndactyly was removed and a double tendon graft from the ipsilateral plantaris tendon was used to reconstruct the FDP tendons of the index and middle finger (Fig. 1B). Due to persistent apical osteitis, with no pulp sensory recovery associated with cold intolerance and secondary exclusion of the index finger, second ray resection according to Chase’s method [5] and flap debulking was requested 6 months later by the patient, together with sensory improvement of the flap due to difficulties in performing key-pinch. The lateral antebrachial cutaneous nerve (LACN) remaining from the previous operation was dissected and prepared for later neuroorrhaphy. Under the microscope, a 0.5 cm rounded epineural window was created on the radial side of the radial proper palmar digital nerve of the middle finger in the palm just distal to the common palmar digital nerve division. An end-to-side neuroorrhaphy was performed between the LACN and the radial proper palmar digital nerve of middle finger, using four 10-0 nylon sutures (Fig. 1C). Post-operatively, mild discomfort at the site of nerve repair was present for the first 6 months, with gradual distal progression of the Tinel sign.

At 5 years’ follow-up, the sensory recovery was assessed by means of pain perception, hot and cold temperature perception, light touch sensation, static two-point discrimination (S-2PD) and moving two-point discrimination (M-2PD), an electrophysiological

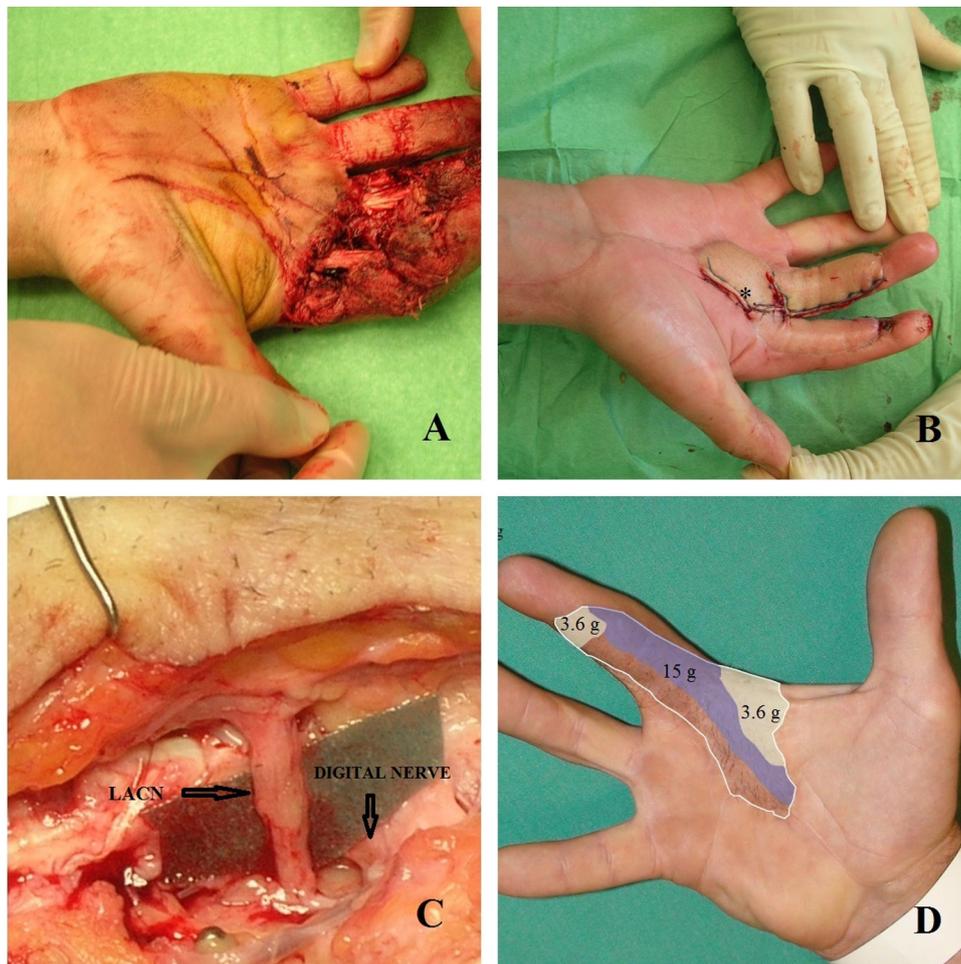


Fig. 1. Complex lesion of the index, middle finger and palm with loss of proper digital nerves of the index and middle fingers (A). A 7 x 3 cm classic distally based radial forearm flap was used to cover the volar surface of the index, middle finger and palm, after syndactyly removal and flap debulking. The asterisk (*) indicates the site of future end-to-side neuroorrhaphy (B). End-to-side anastomosis used to reinnervate the radial forearm flap between the LACN and the side of the proper palmar digital nerve of the middle finger (C). At 5 years’ follow-up, monofilament testing revealed a highly sensitive area in the proximal and distal palmar region of the flap (3.6 g, in white) and a less sensitive central area (15 g, in violet) (D).

study and sweat test. The intact contralateral palm was used as control. The evaluation of sensory recovery was based on the British Medical Research Council scale, as modified by Mackinnon and Dellon [6] that included more detailed measures of two-point discrimination.

A selective block of both the dorsal digital nerves was performed initially with 6 cc of RapiDocain 1% (Sintetica SA, Mendrisio, Switzerland) on the dorsal side of the proximal interphalangeal joint and of the index finger nerve stumps on the radial side of the base of the second metacarpal bone and on the radial side of the third metacarpophalangeal joint distal, slightly radial to the bifurcation of the common palmar digital nerve.

Pain perception was evaluated using a 27-gauge needle and gross assessment of pinprick, which revealed the patient had good perception in the palm compared to significantly decreased pain perception in the volar surface of the proximal phalanx (P1). Hot and cold temperature perception was tested using 43 °C and 10 °C testing tubes, and revealed good temperature perception in the palm, but decreased perception on the P1 volar surface. Light touch sensation was assessed using the Semmes-Weinstein Aesthesiometer™ (Smith&Nephew Rolyan Inc., Menomonee Falls, WI, USA). The monofilament test revealed a central hypoesthetic area with a perception limit of 15 g (Fig. 1D, violet color) and more sensitive proximal and distal palmar areas of 3.6 g (Fig. 1D, white color). S-2PD and M-2PD were assessed with a Mackinnon-Dellon Disk-Criminator™ (Sensory Management, Towson, USA). Sensibility of the flap was much higher compared to the donor site (S2PD 8 mm vs. 23 mm). The average S-2PD test was 10 mm vs. 8 mm and average M-2PD test was 15 mm vs. 10 mm on the contralateral side.

The sweat test using sodium salt of Quinizarin mixed with sodium carbonate, which is directly correlated to the innervation of the respective surface, revealed areas of normal sweating in the palmar region of the flap and an area of hypohydrosis distally. Nerve conduction studies revealed an electrical response detectable on the flap's surface and distal motor latency equivalent to 334 μV compared to the contralateral side of 952 μV, resulting in a responsive level of 35%, indicating nerve continuity up to the flap surface.

The flap's thickness was greatly reduced at follow-up and perceived as sensate by the patient. No loss of sensibility was detected distally in the area of the recipient nerve more than 5 years after the reconstructive procedure. The patient had a pain-free hand and was pleased with the final outcome.

3. Discussion

The described sensate radial forearm flap provided our patient with good sensibility, similar to normal palm sensation [7,8]. Sensory recovery of the flap corresponded to an S3+ on the sensory recovery scale of the British Medical Research Council, as modified by Mackinnon and Dellon [6]. The difference between flap and donor site sensibility at the forearm is partially due to the extensive dissection and resection of the main sensory nerves in that area. The value of static and moving two-point discrimination in the palm obtained at 5 years' follow-up matched previous reports of excellent sensory recovery after end-to-side neurorrhaphy in the hand [9]. Fatemi et al. [3], who compared moving and static two point discriminations of volar forearm skin before and after transfer as a sensate radial forearm island flap, reported similar 2PD values of the sensate radial flap surface as ours (S-2PD of 8 mm). We found a varying degree of sensibility in different regions of the flap, with the more proximal part in the first web and the most distal one being the best innervated. This is probably due

to the anatomy of the LACN branch which was used for flap reinnervation. It was located more radially under the skin paddle and was cut in the second web space during syndactyly opening followed by second ray amputation. The most distal reinnervated area may be explained by collateral sprouting of the ulnar proper dorsal nerve of the middle finger. We have no explanation for the M-2PD being 15 mm vs. 10 mm on the contralateral side because M-2PD is usually better than S-2PD [10]. Although recipient bed axonal sprouting can occur in non-innervated flaps through a still-undefined mechanism [11], this phenomenon is unlikely to account for S3+ sensory recovery. Previous reports have described sensory recovery in non-innervated flaps [12], but only to a small degree, and no other published report has described a spontaneous S3+ sensory recovery. However, in all spontaneous reinnervation cases, sensibility remains only protective and two-point discrimination does not recover in free or pedicled flaps with a thick skin paddle, but only Wallerian degeneration and a loss of nerve fibers can be observed [10].

Compared to other sensate radial forearm flaps reported for oral cavity reconstruction [11,12], increased sensibility was found in our case based on S-2PD. The selective blocks performed of the dorsal digital nerves and the volar index nerve stumps prior to sensory testing confirm that flap re-innervation in the long term is not due to collateral sprouting from other nerves. When reconstruction with a re-innervated flap is mandatory, selection of the recipient nerve is determined upon availability. A transected nerve should always be the first option for end-to-end neurorrhaphy [11]. A previous study [3] has described the use of a digital nerve in an end-to-end fashion to re-innervate a flap; however, there was a loss of sensibility in the donor nerve's innervation area and difficulty in performing key pinch when the radial side of the flap has to be reconstructed. In our case, the LACN and the recipient digital nerve were a good match due to similar diameter and number of fascicles.

This case report shows that the RFF can provide good functional coverage of the palm together with good sensitivity (S3+) compared to end-to-side reinnervation between LACN and the digital nerves. This paves the way for a whole array of potential new sensate free flaps using end-to-side neurorrhaphy in the hand and should be further pursued.

Disclosure of interest

The authors declare that they have no competing interest.

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