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IDEAS AND INNOVATIONS

Peripheral Nerve

TMR for Peripheral Sensory Nerve Neuroma around the Wrist Utilizing the Distal Anterior Interosseous Nerve

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Summary: Injury to the peripheral sensory nerves of the hand and wrist is common and can lead to debilitating neuromas and significantly impair patients' quality of life. Target-muscle reinnervation (TMR) is a novel method for treating neuromas that can result in significant clinical improvement. However, TMR for the peripheral sensory nerves in the hand and wrist is restricted by the limited options for motor branches. The adaptability of the anterior interosseous nerve (AIN) as a target for TMR treating peripheral sensory neuroma has not been thoroughly investigated or implemented therapeutically. This study aimed to evaluate the use of AIN as a viable recipient of TMR for treating peripheral sensory neuromas around the wrist. In this retrospective study, eight patients were included over 18 months from June 2021 to January 2023 at Hamad Medical Corporation. The average follow-up time after TMR was 13 months. The peripheral sensory nerves involved were the radial sensory nerve in five cases, the palmar cutaneous branch of the median nerve in one case, and the median nerve in one case. The preoperative average VAS pain score was 7 of 10 compared with the postoperative pain score of 2 of 10. In conclusion, the AIN can be used as a first-choice motor target for all peripheral sensory neuromas around the wrist for the following reasons: first, it can be reached by the peripheral sensory nerves around the wrist; second, the pronator quadratus muscle is expandable; and third, the AIN can be taken with a long proximal tail for flexible coaptation with the peripheral sensory nerves. *(Plast Reconstr Surg Glob Open 2024; 12:e5531; doi: 10.1097/GOX.0000000000005531; Published online 19 January 2024.)*

INTRODUCTION

Injury to the peripheral sensory nerves in the hand and wrist is common and can lead to debilitating neuromas and significantly impair patients' quality of life.[1,2] Although several surgical techniques for treating painful neuromas have been described, all of them are still debatable because of their varying chances of recurrence.[1–4]

If proximal axons regenerate in an uncoordinated or partial manner after injury to a peripheral nerve, a neuroma may form. In the afflicted nerve distribution, patients with symptomatic neuromas may complain of pain, paresthesia, numbness, cold intolerance, or complicated regional pain syndrome.[3,4]

The present surgical methods to prevent the development of neuromas or to treat those that already exist are unpredictable and frequently ineffective. It has been common practice to treat neuromas using traditional methods, such as nerve translocation, which entails removing the affected nerve segment and implanting the remaining portion in a bone or muscle. However, this approach does not substantially address the desire of the nerve stump for regeneration and does not offer a solution for regeneration without neuromas. This may cause symptoms to return and may fail to lessen pain.[1,2]

To date, there are several options for treating peripheral neuromas. However, the most efficient therapy for treating neuromas that can result in significant clinical improvement is targeted muscle reinnervation (TMR).[2]

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This study aimed to evaluate the use of the anterior interosseous nerve (AIN) as a viable recipient of TMR around the wrist.

METHODOLOGY

We report eight cases of peripheral sensory neuroma around the wrist. All patients were treated by the same surgeon (M.M.) with TMR, using the AIN as an end-motor target for the sensory nerves. All procedures were performed at the Hamad Medical Corporation from October 2020 to February 2022. Two patients had previous attempts at neuroma reconstruction by nerve grafting and translocation by other surgeons. However, in both cases, patients continuously complained of unrelieved pain and lifestyle restrictions. Patient charts were reviewed for nerve involvement, cause of neuroma, preoperative and postoperative pain, TMR target, and complications. The diagnosis of neuroma was entirely based on proper history taking and clinical examination (including nerve block). Nerve block with ultrasound guidance was effective in confirming the diagnosis and preparing the patient for possible future numbness in the dermatome corresponding to the sensory nerve transferred.

TECHNIQUE

Nerve coaptation was performed using loupe magnification with epineurial sutures between the distal AIN and proximal end of the peripheral sensory nerve by using Ethilon 9/0 sutures. All nerve coaptations were sealed with fibrin glue (Figs. 1–3). However, whenever extra length was necessary for the peripheral sensory nerve to reach the motor target, the AIN was taken with a long proximal tail distal to the motor branches of the flexor pollicis longus (FPL) and flexor digitorum profundus (FDP) with only muscle loss to the pronator quadratus (Fig. 4). The pronator quadratus muscle is expandable in patients with functional pronator teres.

COMPLICATIONS

No surgical site infections or hematomas were observed. All seven patients reported numbness along the dermatome distribution of the offended peripheral sensory nerves that were transferred to their motor targets. In addition, there was no change in motor function for either the FPL or the FDP.

RESULTS

Eight patients were included in this study: seven women and one man, with an average age of 44 years (Table 1). The average time from suspected initial injury to surgery was 3.5 years. The average follow-up time from TMR was 13 months. Two of eight patients had prior neuroma excision and reconstruction by nerve graft and translocation. Both were symptomatic for neuroma for 6 and 9 months before being surgically treated by the author. Peripheral sensory nerves were involved in the radial sensory nerve (RSN) in six cases, the palmar cutaneous branch of the median nerve in one case, and the median nerve in one case. Iatrogenic injury to the peripheral sensory nerves during elective surgery was reported in five of eight cases, De Quervain tenosynovitis release in four cases, and volar wrist ganglion in one case. The preoperative average VAS pain score was 7 of 10, compared with the postoperative pain score of 2 of 10.

Takeaways

Question: Can the anterior interosseous nerve (AIN) be used as a motor target for TMR treating peripheral sensory neuroma at the wrist?

Findings: TMR can be successfully applied for the treatment of symptomatic sensory neuromas around the wrist, and the AIN can be used as a first-choice motor target for all peripheral sensory neuromas around the wrist.

Meaning: Treating neuromas around the wrist restricted by limited options for motor targets, the AIN represents a viable option for peripheral sensory neuromas.

DISCUSSION

The peripheral sensory nerves around the wrist are superficially distributed, making them susceptible to iatrogenic injury during hand and wrist procedures. For

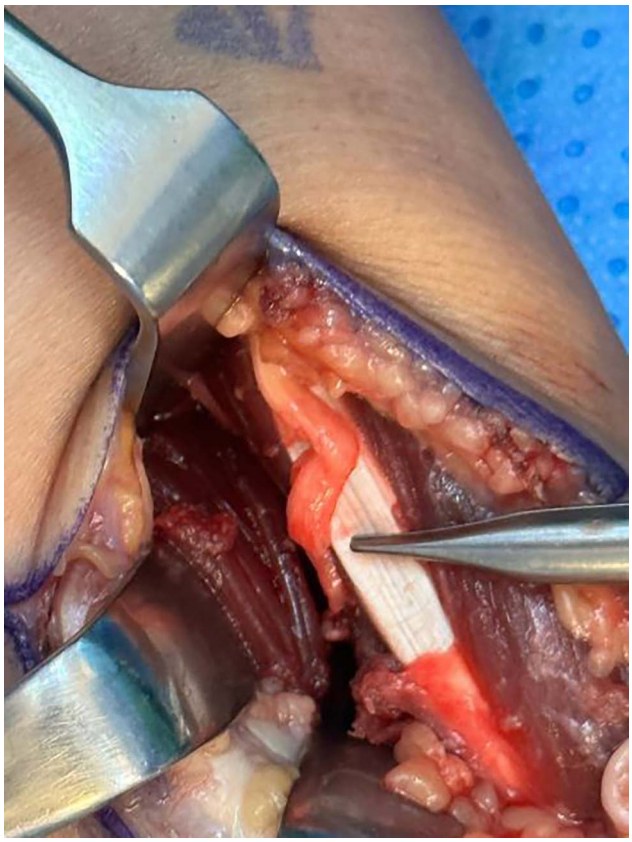

Fig. 1. TMR of SRN to the distal end of AIN after neuroma excision.

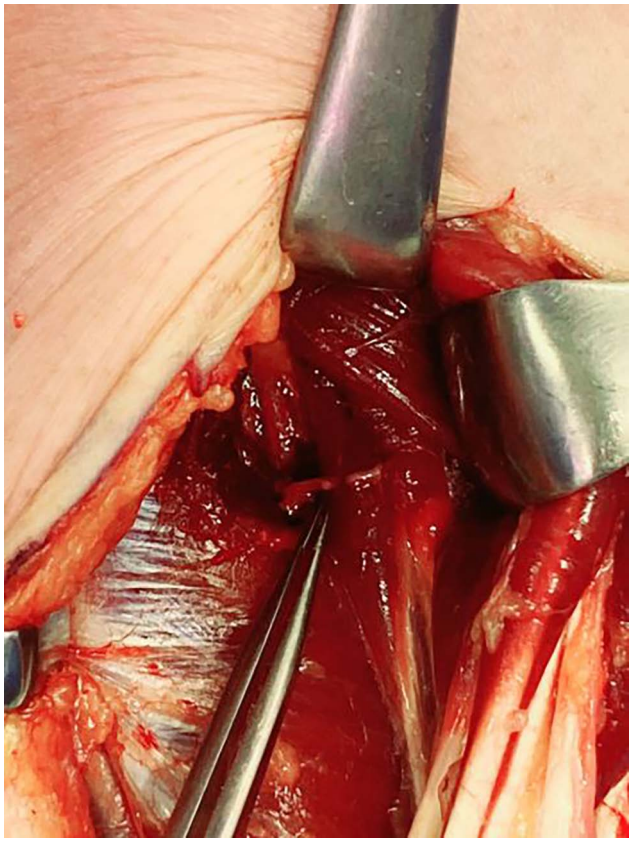

Fig. 2. TMR for PCBMN neuroma to AIN.

instance, RSN is a peripheral sensory nerve that is susceptible to injury during a variety of routine procedures such as intravenous cannulation, initial extensor compartment release, and radial-sided wrist surgery. (**See figure, Supplemental Digital Content 1**, which displays failed SRN neuroma treatment by traditional methods after De Quatrain tenosynovitis release. **http://links.lww.com/PRSGO/D19**.) Injury to the palmar cutaneous branch of the median nerve (PCBMN) is commonly missed following volar wrist ganglion excision, carpal tunnel release, and distal radius fracture fixation, leading to debilitating neuromas. (**See figure, Supplemental Digital Content 2**, which displays missed SRN neuroma after wrist laceration, Neuroma involving all nerve branches of the nerve. **http://links.lww.com/PRSGO/D20**.)

TMR is a physiological surgical procedure that has been shown to reduce and prevent neuroma discomfort. Targeted muscle reinnervation, which was first reported as a method to provide amputees with better control of the myoelectric prosthesis, involves the transfer of the distal end of a damaged peripheral nerve to an adjacent disposable motor nerve. Numerous studies have found that TMR reduces the frequency of painful neuroma formation and phantom limb discomfort in amputees.[5–7]

Neuroma, in general, is either a distal-end neuroma or a neuroma in continuity. Distal-end neuromas should

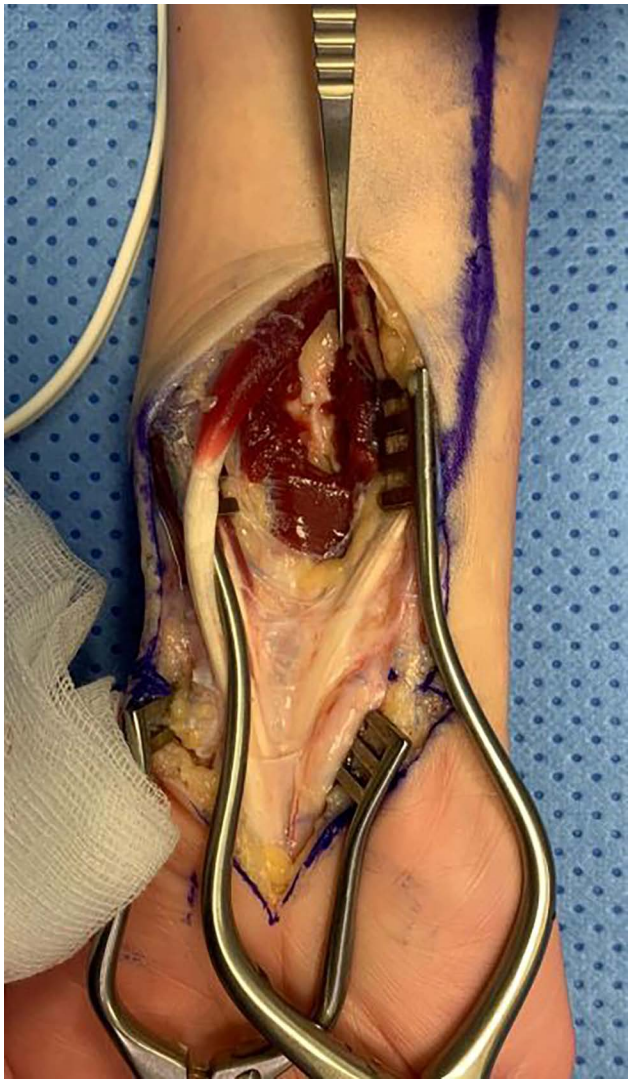

Fig. 3. TMR of a neglected distal end neuroma of median nerve for 7 years to AIN as a motor target.

be treated using TMR. In cases of neuroma in continuity, TMR is required for patients with failed nerve reconstruction or who have nerve gaps that are too long to be adequately repaired after neuroma resection.[2] However, in peripheral sensory neuroma around the wrist, injury might occur at a point where they give rise to branches, making reconstruction attempts futile.

The TMR for the peripheral sensory nerves in the hand and wrist is restricted by the limited options of motor branches that are suitable for coaptation. The adaptability of the AIN as a target for TMR treatment of peripheral sensory neuroma has not been thoroughly investigated or implemented therapeutically.[8] In patients with functional pronator teres, the loss of pronator quadratus function is tolerable. These features make the AIN a good candidate for use in TMR.

The advantages of using the AIN as a target for TMR are as follows: first, it can be reached by the peripheral sensory nerves around the wrist; second, the end target

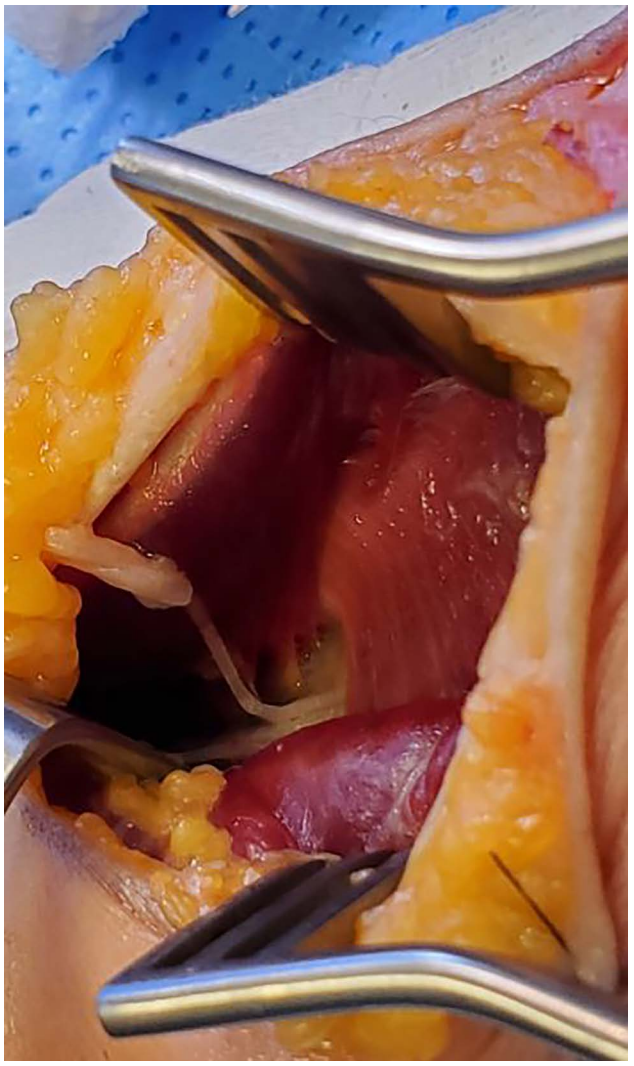

Fig. 4. TMR for SRN neuroma. AIN was taken with a long proximal tail distal to the motor branches of FPL and FDP.

of the AIN is expandable and can be compromised; and third, the AIN can be taken with a long proximal tail just distal to the motor branches of the FPL and FDP for flexible coaptation with short proximal ends of peripheral sensory nerves.[8,9]

TMR is a proven method for improving patients' quality of life and reduces pain.[10,11] The overall results of our patients were encouraging. Patients required fewer over-the-counter drugs because their pain frequency and intensity were greatly reduced. After surgery, their physical health and quality of life improved significantly. However, surgery results in a permanent loss of sensation in the area served by the damaged sensory nerve,[12,13] which must also be disclosed to the patients.

In conclusion, TMR can be successfully applied for the treatment of symptomatic sensory neuromas around the wrist, and the AIN can be used as a first-choice motor target for all peripheral sensory neuromas around the wrist.

Table 1. List of Nerve Distribution of Symptomatic Neuromas, Etiology, and Prior Neuroma Excision

Symptomatic Neuroma	Etiology	Prior Neuroma Excision
RSN	DeQuervain tenosynovitis release	No
RSN	DeQuervain tenosynovitis release	No
RSN	DeQuervain tenosynovitis release	No
RSN	DeQuervain tenosynovitis release	No
RSN	Traumatic wrist laceration	Yes
RSN	Traumatic wrist laceration	Yes
PCBMN	Volar wrist ganglion excision	No
Median nerve	Volar wrist laceration	No

PCBMN: Palmar Cutaneous Branch of Median Nerve

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DISCLOSURE

The author has no financial interest to declare in relation to the content of this article.

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All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. Qatar National Library has fully funded the publication.

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