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IDEAS AND INNOVATIONS

Peripheral Nerve

Use of Supinator Motor Branches in Targeted Muscle Reinnervation of the Superficial Radial Nerve

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Summary: Symptomatic neuromas of the superficial radial nerve (SRN) can cause debilitating pain. Traditional surgical management options have demonstrated inconsistent outcomes prompting a search for alternatives. Recent reports have emerged on the use of targeted muscle reinnervation (TMR) for neuromas of the SRN using donors that are well established in hand surgery, such as the brachioradialis (BR) or extensor capri radialis longus or brevis. Use of the brachioradialis or extensor capri radialis longus motor targets can require surgery at or above the level of the antecubital fossa, and denervation of these muscle groups may be undesirable in cases of complex upper extremity injury where these donors may be needed for tendon or nerve transfer. The supinator is an expendable and often overlooked donor nerve that has not been assessed as a target for TMR of the SRN. In this case series, three patients with SRN neuromas whose conservative management failed and who did not have an SRN lesion amenable to reconstruction were managed with TMR to the nerves to supinator. At latest follow-up (9–22 months), no patients had deficits in supination or evident donor site morbidity. Two patients reported complete resolution of their SRN neuroma pain, and one patient reported partial improvement. This case series reports early results of TMR of the SRN using nerves to supinator in cases of SRN neuromas not amenable to reconstruction, demonstrating technical feasibility, improvements in neuroma pain, and no discernible donor morbidity. *(Plast Reconstr Surg Glob Open 2024; 12:e5512; doi: 10.1097/GOX.0000000000005512; Published online 10 January 2024.)*

INTRODUCTION

Superficial radial nerve (SRN) injuries are notoriously difficult to treat, and it has been suggested that there may be an anatomical basis rendering the SRN prone to neuroma formation after injury.[1] Traditional management (excision and repair, excision and burial, or neurolysis) for neuromas of the SRN have demonstrated inconsistent outcomes with 68% of patients reporting improvement and high rates of secondary surgery (20%).[2]

The paradigm for management of painful neuromas is shifting toward techniques that provide physiologic targets for innervation, such as regenerative peripheral nerve interface and targeted muscle reinnervation (TMR).[3] Although reports have demonstrated effectiveness of TMR in the management of a variety of upper extremity nerve injuries, few studies have reported the use of TMR for management of painful neuromas of the SRN.[3,4]

Recent reports demonstrate promising early outcomes of TMR of the SRN to motor branches of the extensor carpi radialis brevis (ECRB)[5] and posterior interosseous nerve (PIN),[6] with cadaveric studies demonstrating technical feasibility of TMR of the SRN to the extensor carpi radialis longus and brevis (ECRL/ECRB), brachioradialis (BR), and anterior interosseous nerve.[3,7] Although motor targets such as the BR, ECRL, or ECRB can be used, exposure of these motor targets can require surgery at or proximal to the elbow. Denervation of these muscle groups may be undesired in cases of complex upper extremity injury where these critical donors may be needed for other tendon or nerve transfer procedures. Sacrificing ECRB innervation may also lead to radial deviation of the wrist with extension, particularly in patients with concomitant nerve injuries. For these reasons, we prefer an alternative donor. In this article we introduce TMR of the SRN using nerves to the supinator.

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SURGICAL TECHNIQUE

A longitudinal incision overlying the interval between the BR and ECRL is made under tourniquet control. Dissection is carried down to the fascial interval between the BR and ECRL (Fig. 1A). The posterior antebrachial cutaneous nerve is an anatomic marker for this interval and should be protected. Fascia over the interval is opened and dissection is carried down to the radial nerve branches at the arcade of Frohse. The first nerve identified will be the SRN. This is dissected for adequate length. Adjacent and lateral to the SRN is the motor nerve to the ECRB, which is protected. Once done, the radial tunnel is released by identifying the PIN coursing lateral and obliquely to the nerve to ECRB. The vascular leash of Henry crossing the PIN is ligated and the edge of supinator (arcade of Frohse) and any compressive bands are released.[8,9] Attention is turned to identifying the supinator motor branches lying on either side and slightly posterior to the PIN. These can be confirmed with electrical stimulation. The approach can typically be completed prior to onset of tourniquet palsy; however, it can also be performed with no tourniquet and injection of diluted epinephrine subcutaneously at the incision site. The SRN neuroma is resected leaving enough length on the remaining SRN for a tension free coaptation to the supinator branches. The supinator branches are transected just proximal to their entry into muscle and coapted to the SRN using 9-0 nylon and fibrin glue. (Fig. 1B). If desired, a vascularized cuff of BR muscle can be dissected and draped over the coaptation, acting as a vascularized regenerative peripheral nerve interface to capture any potential axonal overflow.

Takeaways

Question: Can targeted muscle reinnervation (TMR) of the superficial radial nerve (SRN) to the supinator motor branches be used as a treatment option for SRN neuromas?

Findings: We present three cases of a new approach for SRN neuroma management using TMR of the SRN to the supinator motor branches. All patients experienced improvement in pain scores postoperatively with no appreciable motor deficits.

Meaning: These results demonstrate that TMR of the SRN to the supinator motor branches seems to be a treatment option with minimal donor morbidity for SRN neuromas in patients without other options for reconstruction.

RESULTS

Three patients presented without options for SRN reconstruction. Two had end neuromas with no distal target, and one had neuroma-in-continuity over a long distance with minimal distal SRN function and a large gap after neuroma excision precluding reconstruction. In all three, conservative measures failed, including hand therapy, desensitization, graded-motor imagery and pain management. All patients underwent TMR of the SRN to the branches to the supinator. Patient demographics, case history and visual analog scale (VAS) pain scores are displayed in Tables 1 and 2. At latest follow-up (9–22 months), two patients reported complete resolution of pain in the SRN distribution. The third patient had partial improvement of their SRN neuroma pain from VAS 6 to 3. Notably, this patient had multiple site chronic nerve pain

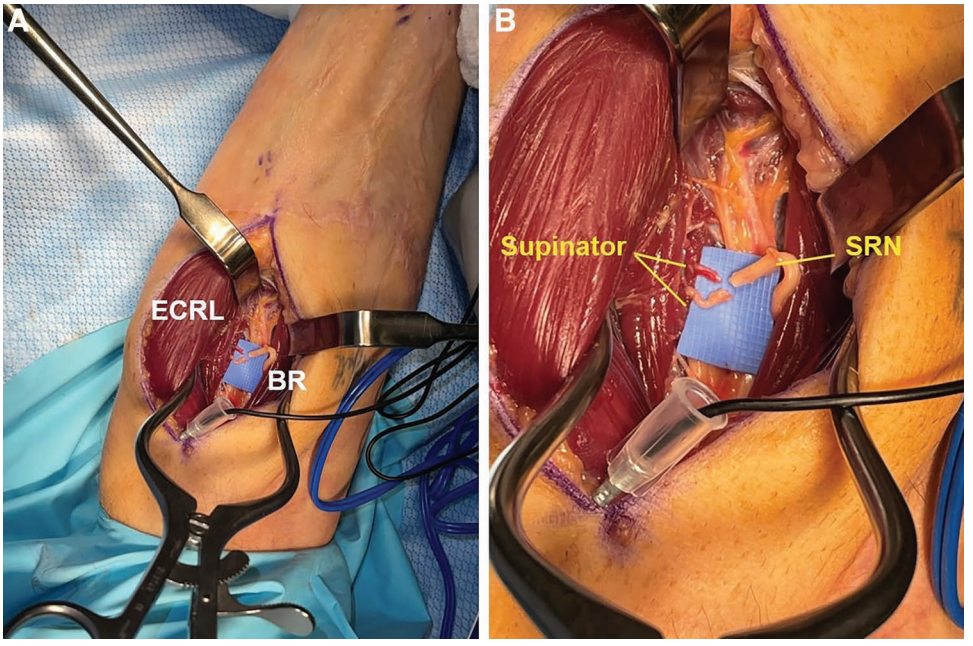

Fig. 1. Surgical approach. A, The interval used to approach the PIN branches, between the extensor carpi radialis longus and the brachioradialis muscles. B, The anatomy of the superficial radial to supinator nerve transfer that was used for TMR.

Table 1. Neuroma Characteristics and Description of Postoperative Course for Each Patient

	Age* (y)	Mechanism of Injury	Referral Type	Neuroma Type	Postoperative Course
Case 1	11	Traumatic injury	Referred for surgical evaluation due to persistent pain limiting activities	Neuroma-in-continuity over a long distance with minimal distal SRN function	Rapid complete resolution of pain
Case 2	42	Iatrogenic injury to SRN following radial forearm flap	Internal patient to plastic and reconstructive surgery being followed up after radial forearm phalloplasty	End neuroma with no distal target for reconstruction	Transient allodynia of the dorsal hand which resolved after 3 wk. No recurrent SRN distribution pain since.
Case 3	31	Iatrogenic injury to SRN following radial forearm flap	Internal patient to plastic and reconstructive surgery being followed up after radial forearm phalloplasty	End neuroma with no distal target for reconstruction	Initial complete resolution of pain for 3 months (VAS 0) followed by development of pain with supination (VAS 3); Notably, this patient has concomitant chronic nerve pain at multiple sites preoperatively and postoperatively.

*Age at the time of operation.

Table 2. Pain and Supination Power Scores, by Patient

	Preoperative VAS Score	Postoperative VAS Score*	Follow-up Time (Months)	Postoperative Supination MRC Score
Case 1	10	0	9	5: normal power
Case 2	7	0	22	5: normal power
Case 3	6	3	12	5: normal power

*Calculated at the latest follow-up.

preoperatively, with concomitant persistent pudendal neuralgia which was present throughout the postoperative course. No patients underwent revision surgery. All three demonstrated Medical Research Council grade 5 supination postoperatively.

DISCUSSION

Modern treatment of a transected nerve end recognizes the need to provide a physiologic target to prevent or reduce symptomatic neuroma formation. TMR has demonstrated effectiveness in decreasing neuroma pain in many peripheral nerves.[6] However, series reporting its use for neuroma of the SRN have been sparse, perhaps due to an entrenched dogma in hand surgery to avoid surgery for SRN neuroma pain. However, emerging evidence supports the potential use of TMR in the treatment of SRN neuromas.[5,6]

Several recent studies have investigated possible TMR targets for SRN neuromas, with cadaver studies demonstrating the technical feasibility of performing TMR of the SRN into the terminal anterior interosseous nerve,[3,7] and into motor branches to the ECRL, ECRB, and BR.[7] One case report discusses the successful use of TMR of the SRN in an end-to-side fashion into a motor branch of the PIN,[6] and a recent case series reports the management of painful neuroma of the SRN with TMR into a distal motor branch of the ECRB with compelling early improvement in the pain scores in all patients.[5]

The technique described in this study uses TMR of the SRN into the nerve to supinator branches. The supinator motor branches are near the proximal SRN and deep in the forearm away from surface stimulation. They are also a favorable size match for the SRN, unlike many clinical examples of TMR that have substantial donor and recipient size mismatches.[7] The supinator is a reliable nerve-transfer donor with minimal donor site morbidity.[10] In contrast, the ECRB and the ECRL may only have one motor branch available, and TMR in these scenarios can result in denervation of major contributors to wrist extension.[7] TMR to the BR or the ECRL may require a much more proximal incision crossing the elbow joint. The ECRL, ECRB, and BR are common tendon and nerve transfer donors, and saving them may be prudent in the event of any future or concurrent hand trauma. If multiple nerve injuries are present, using the supinator as a target leaves the other previously described targets available for management of other nerve injuries such as a possible coincident median nerve injury.

Although TMR for SRN neuromas is a potential solution for a challenging problem, permanently denervating the territory of the SRN should not be taken lightly. This technique is therefore best used in select patients with known nerve transection and/or SRN neuroma where nerve continuity cannot be restored. Additionally, adjunctive treatments for neuropathic pain should continue to be used as appropriate, including hand therapy focusing on desensitization and graded-motor imagery, though these interventions alone frequently provide inadequate symptom relief. Given that our patient with multisite nerve pain experienced only partial pain relief, a more guarded prognosis may be warranted in this setting.

This article describes a novel technique for SRN TMR using the supinator branches. Early results demonstrate improvement of pain and viability of this technique as an option to treat SRN neuromas in selected patients without options for reconstruction.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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This study conforms to the Declaration of Helsinki put forth by the World Medical Association.

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