

# Targeted Muscle Reinnervation for Surgical Pain Management in Amputees: Clinical Case Series at a Single Academic Medical Institution

Brendan J. MacKay, MD, Bradley Osemwengie, BA, Joash R. Suryavanshi, BA, Nancy E. Swinford, R.T. (R)(ARRT), CCRC, Cameron Cox, BA, Desirae McKee, MD

Texas Tech University Health Sciences Center



## Introduction

The incidence of limb amputation in the United States is on the rise.<sup>1</sup> The function and wellbeing of amputees can be compromised by chronic localized pain due to symptomatic neuromas in the residual limb, phantom pain, and issues with prosthetic use.<sup>2</sup> Targeted muscle reinnervation (TMR) is a novel surgical procedure that transfers residual nerves from amputated limbs to new muscle targets via muscular nerve branches. TMR has been shown to significantly reduce neuroma and phantom pain.<sup>3</sup> In addition, it can facilitate the use of sophisticated prostheses. Most of the established literature has been presented in animal studies, military populations, or at the institution where TMR was first developed.<sup>3-5</sup> In this study, we present preliminary data on a TMR case series at an academic hospital serving the general population in a large catchment area.

## Data Collection Methods

Retrospective review of acute and chronic amputee patients who underwent TMR at our institution was completed. All procedures were done by fellowship trained hand surgeons. Post-operative follow-up data was collected at routine follow-up visits. Specifically, phantom pain, stump pain, and use of narcotic pain medication was evaluated. Pain was patient reported on a 10-point Likert scale. Complications of TMR and/or revision surgeries were cataloged.

## Results (or Findings)

This case series included 12 patients who underwent TMR by 2 different fellowship trained orthopedic surgeons of the hand at our home institution. Pre-operative preparation and surgical procedures were based on institution's standard of care. The average age of included subjects was 40 (range: 19-67). 7 (58.3%) subjects had left-sided amputations and 5 (41.7%) subjects had right sided amputations; 5 (41.7%) amputations were of upper extremity and 7 (58.3%) of amputations were of lower extremities. In all upper extremity cases, the median nerve was transferred during the reinnervation procedure, while the sural nerve was transferred in lower extremity cases. At 4-6 week follow-up, average phantom pain was 3.63 (n = 8, range: 0-8) out of 10, while average stump pain rating was 2.22 (n = 9, range: 0-7) out of 10. At 4-6 month follow-up, average phantom pain was 2.67 (n = 3, range: 2-4) while the average stump pain was 2.00 (n = 3, range: 0-3.5).

There were no reported complications or revisions, and patients are recovering as expected. Additional follow-up is on-going.

**Table 1: Sample of Clinical Cases using Targeted Muscle Reinnervation and Corresponding Connections**

Injury	Site of amputation	Nerve Transfer Reconnections
Traumatic Injury	RUE	1. Musculocutaneous nerve-> pectoralis major 2. Lateral cord/median-> pectoralis major 3. Posterior cord/Radial nerve-> pectoralis minor 4. Right Nerve transfer Medial cord/Ulnar nerve-> pectoralis major
Traumatic Injury	LLE below knee	1. Sural nerve-> lateral head of the gastrocnemius 2. Tibia nerve-> soleus 3. Saphenous nerve-> medial head of gastrocnemius 4. Superficial peroneal nerve-> peroneus longus 5. Deep peroneal nerve-> peroneus longus
Traumatic Injury	LUE	1. Median nerve-> short biceps 2. Radial nerve-> medial triceps 3. Ulnar nerve-> brachialis
Machine injury	LUE	1. Median nerve-> Flexor Digitorum Profundus Muscle 2. Ulnar nerve-> Flexor Pollicis Longus Muscle 3. Radial nerve-> Flexor Digitorum Profundus Muscle
Burn Injury	LLE below knee	1. Sural nerve-> lateral head of the gastrocnemius 2. Tibia nerve-> medial head of gastrocnemius 3. Superficial peroneal nerve-> peroneus longus 4. Deep peroneal nerve-> peroneus longus
Traumatic Injury	RLE below knee	1. Sural nerve-> medial gastrocnemius 2. Tibia nerve -> medial soleus 3. Superficial peroneal nerve -> peroneus longus 4. Deep peroneal nerve-> lateral soleus
Traumatic injury	RLE below knee	1. Sural nerve-> soleus 2. Tibia nerve-> soleus 3. Saphenous nerve-> medial head of gastrocnemius 4. Superficial peroneal nerve-> peroneus longus 5. Deep peroneal nerve-> peroneus longus

## Conclusions

All patients present in this case series show improvement of neuropathic phantom pain symptoms after TMR, without complication or revision. Patients' pain was successfully managed without the need for long-term narcotic pain medication. This study further established TMR as a novel and effective therapy for the management of neuroma pain after limb amputation.

## References

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