Targeted Muscle Reinnervation in the Hand: An Anatomic Feasibility Study for Neuroma Treatment and Prevention

Timothy H.F. Daugherty M.D., M.S., Brian A. Mailey, M.D., Reuben A. Bueno, Jr., M.D., Michael W. Neumeister, M.D.

SIU MEDICINE
INSTITUTE FOR PLASTIC SURGERY

Introduction

- TMR has emerged as a treatment for and prevention of symptomatic neuromas and may be beneficial in the hand
- Anatomic studies to locate the motor nerve entry points (MEPs) of the intrinsic hand muscles have not been performed
- Purpose:
  1. Provide details regarding MEP location based on palpable anatomic landmarks
  2. Determine which MEP can be identified through dorsal or volar approach
  3. Develop recommended sensory to MEP coaptations for TMR at the time of Ray Amputation

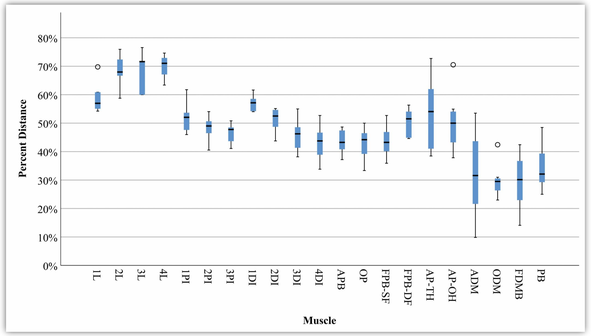
Methods

- 5 fresh latex-injected cadaver hands dissected
- MEP details recorded for each muscle:
  - Number of MEP/muscle & diameter
  - MEP distance measured from volar (hamate hook) and dorsal (Lister's tubercle) landmarks. This is reported as a percent distance between the landmark and the distal most aspect of the metacarpal head (MCH) of the finger onto which the muscle inserts.
- Sensory nerve diameter measured for ratio comparison to MEPs

Results

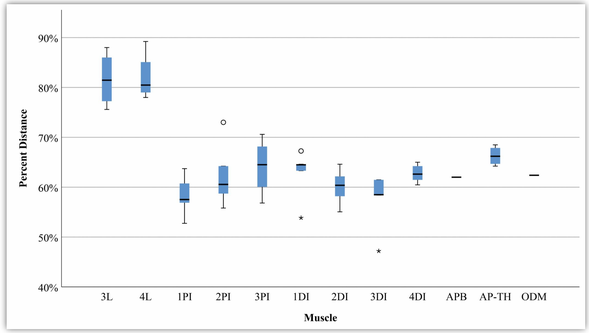
- Number and Diameter of MEPs
  - Most intrinsic muscles had a single MEP
  - Average Diameter range: 0.76mm – 1.76mm
  - Lumbricals & Dorsal interossei MEP diameters significantly larger than palmar interossei ($p<0.001$ and $p<0.0001$)
- Volar Approach (**Fig 1**): MEPs identified to all 19 intrinsic muscles
- Dorsal Approach (**Fig 2**): MEPs identified to 12 intrinsic muscles

Figure 1: Volar MEPs



Boxplot showing percent distance for MEPs identified volarly. Lumbricals had most distal MEPs, approx. 70%, and interossei were around 50%.

Figure 2: Dorsal MEPs



Boxplot showing percent distance for MEPs identified dorsally. Lumbricals had MEPs at approx. 80%. interossei were around 60%.

Table 1: MEPs Identified After Ray Amputation

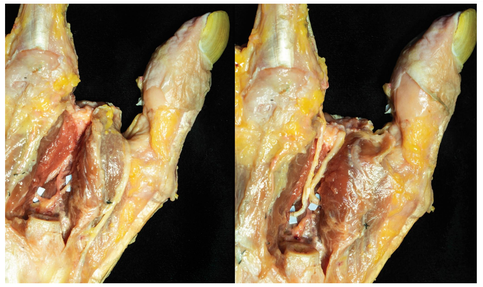
Amputated Finger	Approach	MEPs Identified at Amputation Site	Expendable	Mean Diameter of MEP (mm)	Mean Percent Distance of MEP from Lister's Tubercle to MCH	Recommended TMR Nerve Coaptation: Digital Nerve	Recommended TMR Nerve Coaptation: Diameter Ratio (Sensory:MEP)
Index	Dorsal	**1st Dorsal Interossei**	**Yes**	**1.46**	**63**	**Radial**	**1.32**
		1st Palmar Interossei	**Yes**	**0.98**	**58**	**Ulnar**	**1.69**
Long	Dorsal	**2nd Dorsal Interossei**	**Yes**	**1.26**	**60**	**Radial**	**1.48**
		3rd Dorsal Interossei	**Yes**	**1.26**	**57**	**Ulnar**	**1.24**
		Adductor Pollicis - TH	No	1.1	66		
Ring	Dorsal	**3rd Lumbrical**	**Yes**	**1.12**	**82**	**Ulnar**	**1.50**
		3rd Dorsal Interossei	No	1.26	57		
		4th Dorsal Interossei	**Yes**	**1.22**	**63**	**Radial**	**1.46**
		2nd Palmar Interossei	Yes	0.94	62		
Small	Dorsal	**4th Lumbrical**	**Yes**	**0.9**	**82**	**Ulnar**	**1.71**
		4th Dorsal Interossei	No	1.22	63		
		3rd Palmar Interossei	**Yes**	**0.76**	**64**	**Radial**	**1.95**
		Opponens Digiti Minimi	Yes	1.24	62		
					Mean Percent Distance of MEP from Hamate Hook to MCH		
Thumb	Volar	**Abductor Pollicis Brevis**	**Yes**	**1.76**	**44**	**Ulnar**	**1.09**
		Opponens Pollicis	**Yes**	**1.7**	**43**	**Radial**	**1.05**
		Flexor Pollicis Brevis	Yes	1.26	44		

MEPs identified in amputation site for each digit. Recommended coaptations listed in bold. Index through small finger can be done through dorsal approach. Volar approach is necessary for the thumb due to proximal insertion of MEPs

Conclusions

- TMR is anatomically feasible in the hand.
  1. MEPs are consistent and their locations are predictable when measured from Lister's Tubercle (dorsal) and Hamate hook (volar).
  2. At least two expendable MEPs can be identified through the dorsal approach after Ray amputation of each digit (with exception of the thumb). These are available for coaptation with the digital sensory nerves for prophylactic TMR (**Table 1**)
  3. Favorable diameter ratios of MEPs to sensory nerves (**Fig. 3**)

Figure 3



Cadaver hand after ray amputation of index demonstrating TMR. Left image shows MEPs to the first palmar and dorsal interossei prior to transection. Right image shows the volar digital nerves after coaptation to the MEPs. Favorable sensory:MEP diameter ratio is demonstrated.