The Effects of Targeted Muscle Reinnervation on Neuromas in a Rabbit Rectus Abdominis Flap Model

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J Hand Surg Am. 2012 Aug;37(8):1609-16 doi: 10.1016/j.jhsa.2012.04.044. Epub 2012 Jul 4.

Abstract

Purpose: A targeted muscle reinnervation (TMR) model was created using a pedicled rabbit rectus abdominis (RA) flap to receive the input from previously amputated forelimb neuromas. We hypothesize that a segmental muscle flap can undergo TMR and that it is possible to differentiate the signal from 3 independent nerves. In addition, by virtue of the nerve coaptation, the morphology of the previous amputation neuroma would become more like that of an in-continuity neuroma.

Methods: Five New Zealand white rabbits had a forelimb amputation. In a second-stage surgery, an RA flap was transposed onto the chest wall. After neuroma excision, 3 neurorrhaphies were made between the median nerve, radial nerve, and ulnar nerves, and 3 motor nerves of the RA. After 10 weeks, the electrophysiologic properties of the reinnervated flap were tested. Nerve specimens from the median, radial, and ulnar nerves were harvested before and after TMR to quantify the histomorphometric changes effected by TMR on the mixed nerve neuromas.

Results: Of the 12 nerve coaptations performed in the 4 viable flaps, all 12 were grossly successful. Muscle surface EMG data demonstrated that the RA retained its segmental innervation pattern after TMR. Similarly, prolonged stimulation of 1 nerve reinnervating the RA resulted in the depletion of glycogen specific to the territory of the muscle stimulated by that nerve. TMR was found to favorably alter the histomorphometric characteristics of the neuroma by decreasing myelinated fiber counts and increasing fascicle diameter in the transferred nerves.

Conclusions: This study demonstrates that 1 segmented muscle having TMR by multiple nerve ingrowth and in turn generate discrete EMG signals. During this process, the previous amputation neuroma undergoes favorable morphologic alteration.

Clinical relevance: Based on these preclinical results, this technique might be useful in upper extremity amputees to recruit target muscles to have reinnervation to drive myoelectric prostheses and to treat symptomatic neuromas.

PMID: 22770416 DOI: 10.1016/j.jhsa.2012.04.044