Characterizing Sonomyographic Control and Motor Learning for Targeted Muscle Reinnervation Interfaces

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Abstract**:**

Targeted muscle reinnervation (TMR) leverages surgically reinnervated muscles as biological amplifiers for intuitive prosthetic control. Ultrasound-based sonomyography (US) offers a novel means of capturing muscle contractions, supporting proportional, multi-degree-of-freedom control. This study pursued two primary aims: (1) identify optimal sonomyographic control parameters and characterize how control performance evolves over time following TMR surgery, and (2) establish a platform for evaluating motor learning using US-based proportional position control. To address Aim 1, two TMR participants were assessed at multiple post-surgical timepoints. US recordings captured muscle activation during functional grasp patterns (e.g., power) to track the evolution of control. For Aim 2, able-bodied participants performed a subset of grasps to match graded levels of virtual hand closure across multiple sessions and feedback conditions. Preliminary results demonstrate that four to six grasps can be classified with 82% to nearly 100% accuracy, showing improvements six to nine months post-TMR. Able-bodied participants exhibited reliable proportional control, accurately modulating virtual position according to the graded target, even with gain manipulations between movement and visual feedback. Overall, these findings support US-based sonomyography as a feasible platform for tracking motor learning and stabilizing control outcomes, with implications for optimizing the timing of prosthesis prescription following upper limb loss.

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