Orthotics and Prosthetics

Combining Targeted Muscle Reinnervation Surgery with Pattern Recognition to Improve Prosthesis Control

Upper limb amputation has ranked as one of the most severe combat-related orthopaedic injuries and remains a significant cause of long-term disability for Veterans. Unfortunately, upper limb prosthetic technologies still fall far short of what is needed to replace lost limb function, especially for young, fit military personnel. The current devices provide limited function and are heavy, uncomfortable, and awkward to control.

Researchers at the Rehabilitation Institute of Chicago (RIC; now renamed to the Shirley Ryan AbilityLab; Chicago, Illinois) conducted a study involving subject participants with targeted muscle reinnervation (TMR) and compared direct control to pattern recognition control of a commercially available powered upper limb prosthesis (*Hargrove et al. 2017*). Clinicians from the Shirley Ryan AbilityLab, Walter Reed National Military Medical Center (Bethesda, Maryland), San Antonio Military Medical Center (San Antonio, Texas), and other facilities where the TMR procedure has been performed assisted in subject recruitment.

TMR is a procedure in which the nerves that previously controlled the missing arm are sewn on to ‘target’ muscles that no longer do anything because the arm is gone. Even though the arm is missing, the brain still sends messages down these nerves telling the arm how and when to move. The transferred arm nerves reinnervate the target muscles so that when the person tries to move the missing arm the target muscle contracts. When the target muscles contract they make electrical signals, called electromyography signals (EMG), that are detected by electrodes on the skin surface. These EMG signals are used to control a prosthesis—so that when the person tries to move their missing arm the prosthesis follows these commands and moves in the desired manner. Pattern recognition control uses the EMG signals to enable intuitive control of prosthetic devices.

The subject participants with TMR compared conventional direct control to pattern recognition control with a commercial arm system (Boston Digital Arm) over six to eight weeks during an in-home trial (Figure 1). Seven out of eight subjects preferred pattern recognition control over direct control. Statistical analysis also demonstrated that pattern recognition has functional advantages over direct control. Subjects then completed a further home trial using the Rehabilitation Institute of Chicago Arm to evaluate the ability to control additional degrees-of-freedom. The RIC Arm is a modular prosthetic arm that is 30 percent lighter than commercial devices, can fit the 25th percentile female or larger patients, is very robust, and is also considered very “smart”.

Many Service members with upper extremity amputations have had the TMR surgical procedure already. Combining the TMR procedure with pattern recognition will provide more intuitive control of a prosthetic arm with multiple degrees of freedom.

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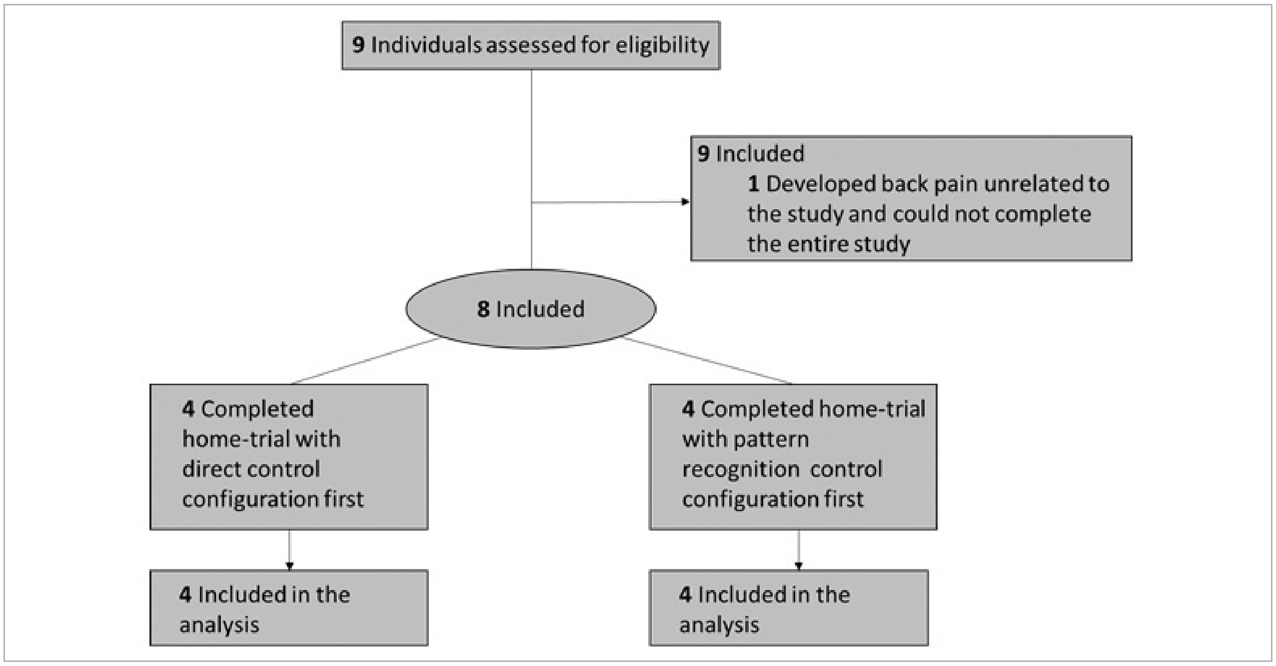

FIGURE 1: Schematic of randomized block design. (Figure 1 from Hargrove et al. (2017) used with permission from the authors)

REFERENCES:

Hargrove, L. J., Miller, L. A., Turner, K., and Kuiken, T. A. 2017. "Myoelectric Pattern Recognition Outperforms Direct Control for Transhumeral Amputees with Targeted Muscle Reinnervation: A Randomized Clinical Trial." Sci Rep 7 (1):13840. doi: 10.1038/s41598-017-14386-w.