Physiology of Targeted Muscle Reinnervation

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BME 281 Presentation, March 18, 2011 <luke_lasorsa@my.uri.edu>

Abstract—Targeted muscle reinnervation (TMR) is a surgical intervention to improve the control of myoelectric prostheses in high-level upper-limb amputation. I hope to briefly describe the procedure and the protocol for postoperative, preprosthetic care. This to me is a very exciting development in biomedical engineering, and one that deserves a great deal of attention.

I. Introduction

Controlling prostheses at the transhumeral and shoulder disarticulation levels of amputation is challenging. Several mechanical joints need to be operated, but limited inputs for control exist. Targeted muscle reinnervation (TMR) is a new elective surgery that increases the number of EMG control signals, thus improving the potential for enhanced prosthetic function.[1] TMR takes advantage of intact residual nerves that previously connected to muscles distal to the amputation. The intact residual peripheral nerves are transferred to surgically denervated areas of unused musculature in the residual limb or chest (**Figure 1**).[4] The arm and hand nerves are transferred to reinnervate the "target" muscle so that the nerves represent the absent limb physiologically. These new target muscle contractions correlate physiologically to the movements of the prosthetic device.

II. Procedure

The therapy occurs in four phases: surgical procedure, post surgical program before TMR fitting, diagnostic fitting, and multifunction prosthesis training.

TMR is generally performed several months after the initial trauma when the residual limb has healed. The surgery involves two to four nerve transfers and is accomplished in a 2- to 5 hour operation. The initial issues are pain and edema.

An important goal following TMR is strengthening re innervated muscles so they generate electrical signals that can be detected by surface electrodes. Strengthening the contraction of the transferred-nerve muscles before the fitting helps the patient develop the adequate endurance needed to proceed with TMR myoelectric prosthetic training. When the target muscles are adequately re-innervated, patients with transhumeral amputation are expected to be able to independently and intuitively control elbow flexion (musculocutaneous nerve) and extension (proximal radial nerve) from their natural, undisturbed lateral biceps and medial triceps muscles.[4] The prosthetic fits patients with a diagnostic socket using independent myoelectric control of four functions: elbow flexion, elbow extension, hand open, and hand close. User intentions are reflected in the signal and corresponding functions of the prosthesis

III. Results

After the completion of the necessary rehabilitation the patient can expect to have the dexterity and motor function to do a plethora of simple, but essential tasks. tying shoelaces or a necktie, folding or hanging clothes, and removing money or credit cards from a purse or wallet. [3]

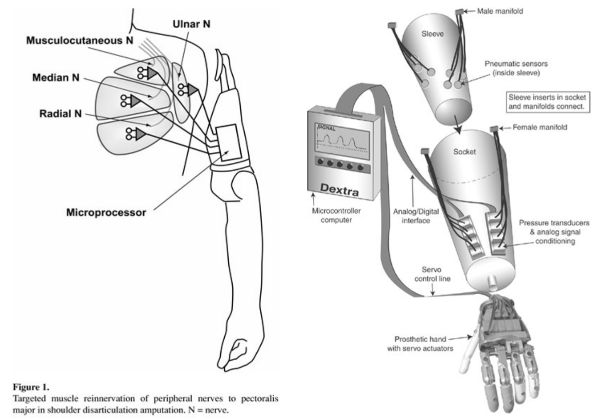

Figure 1.
Targeted muscle reinnervation of peripheral nerves to pectoralis major in shoulder disarticulation amputation. N = nerve.

IV. Discussion

Myoelectrics are a particularly exciting yet costly form of rehabilitation treatment. The treatment is extensive, the medical costs are great, but the ultimate result is a vastly rewarding one both for biomedical engineers and patients. Myoelectrical treatment has yet to see widespread usage but as procedures become more efficient they will also grow to become more commonplace. Inevitably a distinct and promising rise can be expected within the next 10 years. It's a very exciting time in the medical field, when treatments once science fiction are becoming a reality.

References

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