SHOULDER DISARTICULATION FITTING WITH 6 INDEPENDENTLY CONTROLLED MOTORS AFTER TARGETED HYPER-REINNERVATION NERVE TRANSFER SURGERY

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• INTRODUCTION:

In 2002, targeted hyper-reinnervation nerve transfer surgery was performed unilaterally on a bilateral shoulder disarticulation amputee. The goal of this surgery was to create additional sites using the remaining unused brachial plexus nerves to allow simultaneous control of multiple movements using more natural control schemes. 4 new myoelectric control sites were created on the left pectoralis muscle. a goal was set to build a prosthesis with the maximum number of controlled motors available. Six motorized components were identified.

Figure 1: The myoelectric sensors locations.

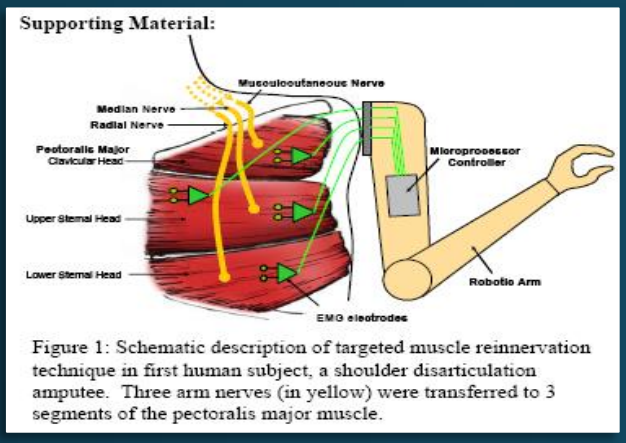
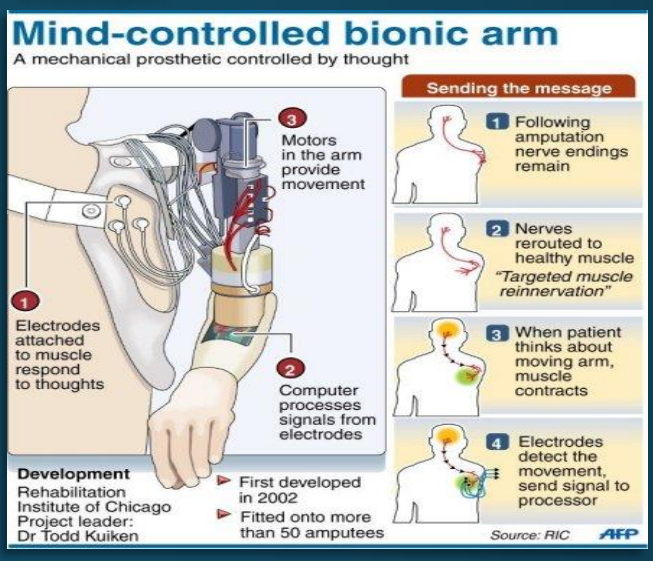


Figure 1: Schematic description of targeted muscle reinnervation technique in first human subject, a shoulder disarticulation amputee. Three arm nerves (in yellow) were transferred to 3 segments of the pectoralis major muscle.

Figure 2: Showing how the Prosthesis takes commands.



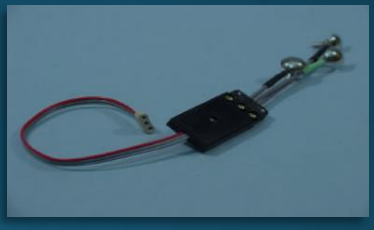
• COMPONENTS:

An experimental prosthesis was built for control by a person with shoulder disarticulation Amputation. The six powered Functions, integrated by LTI, included a prototype shoulder, an experimental humeral rotator, a Boston Digital arm, a wrist rotator, and a hand with powered wrist flexion/extension. A powered shoulder joint.

• The LTI's Remote Electrode System:

It allows the clinician to place the metal electrodes over the best site for acquiring the muscle signal. It is consists of; an Electrode-Amplifier, Metal Electrodes (3) and a Remote Electrode Cable (REC). The Metal Electrodes are placed over the muscle site.

Figure 3: Showing LTI's Remote Electrode System .



• CONTROL:

The subject controlled hand opening and closing, elbow flexion and extension and humeral internal and external rotation using two independent myoelectric signals, for hand open and hand close recorded over the median nerve-muscle unit. The musculocutaneous nerve transfer was used for elbow flexion and the radial nerve transfer was used for elbow extension. The subject had some remaining deltoid musculature that could be used for a myoelectric site. This signal was used to control internal humeral rotation while a latissimus dorsi site was used to control external humeral rotation. To maximize the number of controls mounted in the socket, a rocker switch was positioned superiorly within the socket to control the shoulder. Forward movement of the rocker flexed the shoulder joint (or lifted the arm) and backward movement of the rocker brought the arm down. A force-sensitive resistor (FSR) touch pad was mounted anterior within the shoulder cap to control wrist flexion and a second was mounted posterior to control wrist rotation.

• RESULTS:

The subject was better at pre-positioning the terminal device in space. He was able to demonstrate simultaneous control of at least 3 degrees of- freedom and multiple joints. The nerve transfer EMG controlled functions was the easiest to use. Operation of the humeral rotator with EMG control was also relatively easy. Control functions with shoulder motion were clearly more difficult.

Figure 4: Photographs showing subject using 6-motor prosthesis.