Rehabilitation Institute *of* Chicago

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The Bionic Arm Fact Sheet

What is the bionic arm?

Developed within the Neural Engineering Center for Artificial Limbs (NECAL) at the Rehabilitation Institute of Chicago (RIC), Dr. Todd Kuiken, MD, PhD, pioneered the muscle reinnervation procedure which takes an amputee's own nerves and connects them to a healthy muscle. In this case, four of Mr. Sullivan's nerves were dissected from the shoulder and transferred to the muscles of his chest. Doing so allows the user to move his or her prosthetic arm as if it were a real limb – by simply thinking about what they want the arm to do. The bionic arm, or myoelectric arm, is driven using electrical signals from the muscles of the chest, now activated by the user's own thought-generated nerve impulses. These impulses are sensed, via surface electrodes, from the pectoral muscle and carried through to the mechanical arm, causing the arm to move.

How does it work?

NECAL uses nerve-muscle grafts in amputees to gain added control signals for an artificial arm. Doctors take nerves that used to go to the arm and move those nerves onto chest muscles. The nerves grow into the chest muscles, so when the patient thinks "close hand," a portion of his chest muscle contracts. Electrodes that detect muscle activity tell the computerized arm when to close the hand. Thus, the patient thinks "close hand" and his artificial hand closes.

Why is this important?

Improving the function of artificial arms remains a considerable challenge, especially for high-level amputations where the disability is greatest. Externally powered hooks, hands, wrists and elbows are available, but existing control methods are inadequate. Currently, most powered artificial limbs are controlled using myoelectric signals from a pair of muscles in the amputated limb. This allows only a single motion to be operated at a time, as operation of the terminal device; wrist and elbow must be preformed sequentially. This control method is frustratingly slow, since normal human arm function involves coordinated simultaneous movement of the hand, wrist and elbow. Also, conventional high-level myoelectric control methods do not have a natural feel, as biceps and triceps functions are not directly related to wrist rotation or opening/closing of the human hand. A highly articulated limb is of little use if its movements are not well coordinated or if it is difficult to operate.

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Researchers at RIC have learned that although the limb is lost with an amputation, the control signals to that limb remain accessible in the residual peripheral nerves. Grafting the residual nerves of an upper-limb amputee to spare muscles produces additional control signals, allowing for simultaneous operation of multiple functions in an externally powered prosthesis with a more natural feel than is possible with conventional prostheses.

Has the technology been used successfully?

The bionic arm technology has been very successful so far in both significantly improving the function of artificial limbs as well as allowing the skin to be reinnervated with nerves form the arm. The first patient to undergo the new procedure, Jesse Sullivan, has experienced significant improvements in the functioning of his prosthetic arms. While previously moving his artificial arms was slow and cumbersome, today he is able to do many of the routine tasks he took for granted before his accident, including putting on socks, shaving, eating dinner, taking out the garbage, carrying groceries and vacuuming.

Who manages this project?

NECAL staff includes biomedical engineers, electrical engineers, physiatrists, surgeons, prosthetists and therapists. RIC's Amputee Program is the most comprehensive such program in the country and is recognized internationally for excellent care and the ability to fit the most advanced artificial limbs available. The program is designed to help both adults and children who have any type of limb loss.