Targeted Reinnervation

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Abstract—This paper covers targeted reinnervation and how it can be implemented to improve the quality of life of upper-limb amputees by providing more control and functionality to the traditional upper-limb prosthetics available today.

I. INTRODUCTION

TARGETED reinnervation is a process that involves both a surgery and implementation of a prosthetic device to achieve near pre-injury levels of upper extremity functionality. Not having the ability to use one of your arms can extremely hinder the most mundane daily activities such as brushing your teeth, taking out the trash, getting dressed, etc... Through pre-screening medical evaluations, a moderate surgery, the implementation of a prosthetic arm, and post-op rehab an amputee can significantly improve his quality of life by making daily activities easier. Due to the reassignment of nerves and some muscular limitations, trans-radial amputees are unable to undergo Targeted Reinnervation [TR] at the moment. Studies have shown a 96% success rate and an improvement in function on all testing. Research also suggests that [TR] shows promise in revealing more information about neural plasticity in adults. All of these positive benefits of [TR] make it an extremely viable option for people who have lost an arm.

II. METHOD

The entire process of [TR] relies on the success of a surgical procedure that relocates four nerves of the brachial plexus of nerves; the musculocutaneous, median, radial, and ulnar nerves. Each nerve has a specific function (e.g. musculocutaneous innervates elbow flexors like the biceps), and once successfully relocated to the pectoral muscles allows a prosthetic device to be controlled intuitively. Surface electrodes are placed on the skin that receive the signal from the brain to move a specific part of the amputees arm (in this case, a prosthetic), the electrodes then receive that signal and apply pattern recognition techniques to then interpret what the signal was meant to do. Once the signal is determined it is then sent to the prosthetic device to carry out its task. This process allows the user of the prosthetic device to control it intuitively just as if the arm was his own.

III. SENSORY FEEDBACK

Sensory feedback can also be utilized in order to give the amputee back his/her feeling of touch. A patient agreed to undergo Targeted Sensory Reinnervation [TSR] which includes the relocation of sensory nerves as well as the brachial plexus nerves. As a result of the procedure the patient had near-normal sensory thresholds for stimulation including touch, pressure, temperature, and electrical information. It also showed improvement in the perceptual ownership of the prosthetic providing more ‘control’ over the replacement limb. Representations of sensation of the limb located in the sensorimotor complex indicate both central and peripheral neural plasticity, which opens the doors for more research in that field.

IV. DISCUSSION

Both [TR] and [TSR] provide extremely functional and viable options for amputees who have lost an arm. Although the procedure is ideal for Shoulder Disarticulation [SD] amputees, trans-humeral amputees can also undergo the procedure simply by changing the innervation of two muscles of the upper-arm (short head of the biceps, and either the brachialis or the lateral head of the triceps).

Initially the prosthetic is controlled by ‘direct control’ where one electrode is placed over each muscle and is directly in control over one single motion of the limb. Addition and more complex control schemes that implement additional electrodes to achieve more complex prosthetic movements (e.g. varying degrees of grip strength for different daily activities). Another huge task in improving the prosthetic limb control is finding out exactly how much information can be extracted from the reinnervated muscles. This includes further research into [TSR] to provide sensation to the prosthetic.

Not only does [TR] and [TSR] provide patients with improved physical functionality but it also relieves the patients of the stress that comes with the injury. But there are also major social/emotional impacts that benefit the patient as well. Just being able to wave to your kid as he goes to school could provide a better quality of life for parents who are also amputees. Further research could only benefit the field, and provide amputees with access to an extremely successful and effective procedure.

REFERENCES