SAMPSON'S PROSTHETIC & ORTHOTIC LABORATORY

CLINICAL UPDATE

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CUTTING EDGE TECHNOLOGY INFORMATION IN THE PROSTHETIC ORTHOTIC WORLD

Sampson's Patient First in Capital Region to Have TMR Surgery

On December 11, 2010, John Calenzo's life changed forever when the vehicle he was driving crashed on the New York State Thruway. Trauma included the loss of his arm, broken ribs, and neck and back injuries. "The last thing I remember was a coughing fit and the helicopter ride to Albany Medical Center. I didn't even know I lost my arm until three days later," he recalled.

John, a former tractor trailer driver, heavy equipment operator, and diesel mechanic, was determined to recover as quickly as possible. A few short months after the accident, he was fit with a body-powered prosthesis by Bill Sampson, CP. However, John was having difficulties regaining function with the prosthesis, particularly with the body power needed to control the elbow. Bill then suggested John consider TMR (Targeted Muscle Reinnervation) surgery to give him greater control of his prosthetic hand, wrist, and elbow.

What is TMR?

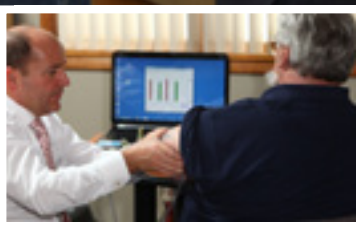
TMR (Targeted Muscle Reinnervation) surgery transfers residual arm nerves to alternative muscle sites, such as the chest (shoulder disarticulation) or upper-arm muscles (trans-humeral amputation). For trans-humeral amputees, the surgery involved changing the innervations of two muscles of the upper arm, the short head of the biceps and the lateral head of the triceps. The original innervations of these target muscles is cut and the median and distal radial nerves are connected. After reinnervation, these alternative muscle sites produce electromyogram (EMG) signals on the surface of the skin. These signals activate a function in the prosthesis to control the prosthetic elbow, wrist, and hand. The goal of this procedure is for the patient to have simultaneous control of multiple degrees of freedom and control of movement in a prosthesis.

TMR was developed by Todd Kuiken M.D., Ph.D., director of the Rehabilitation Institute of Chicago (RIC) Center for Bionic Medicine, and Gregory Dumanian, M.D., chief of the division of plastic surgery at Northwestern University.

Jerome Chao, M.D., Certified Plastic Surgery, Latham, N.Y., executed John's surgery. Dr. Chao was on the team that did the first TMR surgery at Northwestern University with Dr. Kuiken and Dr. Dumanian. He was the chief resident at the time.

"TMR taps into the brain by using nerves in existence and transferring to other muscles so that there are more signals for the prosthetic arm; it's more intuitive in terms of moving that arm," said Dr. Chao. "With John, we divided his bicep into two different signals and divided the triceps into two different signals using nerves that are already there that aren't innervating anything. Now John has a minimum of four signals to extend and flex the elbow and at the same time, open and close the hand.

"For example, the median nerve is used to close the hand," Dr. Chao explained. "Now with the median nerve in the medial head of the biceps, the prosthesis closes the hand when it gets the signal. The brain just thinks, 'close the hand.' Previously the patient would have to click the linear transducer switch after the elbow was bent before the hand could be closed. Now the operation of the arm is much smoother and John should be able to gain a significant amount of function from his TMR surgery," said Dr Chao.



INSURANCE COVERAGE

TMR surgery is covered by Medicare, CDPHP, No Fault, and Workman's Comp because it is a functional operation; it's not a cosmetic operation. However, each patient should check with their own insurance carrier.

"Patients need to be aware of this. TMR is not well publicized like cosmetic surgery. The typical person knows what Botox is, but they don't know TMR surgery. We just need to educate people better."

Post Surgery Recovery and Therapy

An intricate surgery such as TMR would suggest that patients might anticipate some inpatient hospital time. But Dr. Chao said that patients can go home the same day or after an overnight stay. Rehabilitation and learning how to train those newly reinnervated muscles is a much longer process, ranging from four to six months, depending on the individual. It takes several months for the nerves to grow into the muscles and intensive therapy sessions for the patient who needs to learn how to control the new signals.

John began his occupational therapy at about four months post surgery and ideally expects to be wearing his prosthesis six months post surgery. In therapy, John is strengthening reinnervated muscles to generate electrical signals detectable by surface electrodes. A computer system is used that records EMG signals from sensors that are on his arm and he performs exercises to strengthen the movement command that creates the most useful EMG signal. These signals are allowing him to gradually master the art of knowing which muscles control movement.

"During therapy, they put my (prosthetic) hand and arm on a table. As I fire certain muscles, the hand or the arm moves. I'm working to understand which muscles to fire and which ones not to fire," John said. "It's coming along. I'm retraining my arm, what is left of it, to do what it is supposed to do. I'm getting there. It's like building a house. We've got the foundation done."

"What John is learning is called patterning," said Bill Sampson. "He is remembering how to open up his hand and elbow that are not there. He is working on sending that signal from the brain to his elbow and hand. The brain should send the signal down the distal radial nerve to the lateral head of the triceps. If we can get an EMG signal from that, then the signal will control the movement of the hand.

"If the brain sends a signal down the musculocutaneous nerve to the lateral long head of the biceps, then this will control the movement of the elbow. These are just two of the four EMG signals sent by the brain to control movement of the hand and elbow."

High-Tech Components

Bill Sampson has fit John with a Boston Elbow™ and an i-LIMB™ Hand. With all four intact EMG signals working successfully, the patient can have freedom and control of movement at the elbow, wrist, and hand.

"With a successful TMR procedure, I believe I can get back to doing just about anything I want to do," John said.

DR. CHAO DESCRIBES PATIENT'S TMR SURGERY

"I start with the biceps first, make the incision down the middle between the biceps and separate them. The musculocutaneous nerve, which controls elbow movement, is removed from the medial side. The median nerve, which is on the inside of the arm, is transferred to the medial head of the biceps. The median nerve is cut and attached to the motor point where the musculocutaneous nerve branch was previously connected. The musculocutaneous nerve branch now only innervates the lateral biceps and the median nerve will innervate the medial biceps.

"Now John has two different signals, one to the lateral and one to the medial biceps. And to really help the prosthetists, we create an adipofascial flap and we place it between the biceps to really separate those muscles. Before they were attached to each other, now they are separate from each other.

"The second part of the operation the patient is turned face down. We are essentially doing the same surgery to the triceps. I transfer the distal radial nerve (not being used) and bring it to the nerve branches of the lateral head of the triceps, the same way as the biceps. We take the adipofascial flap and separate the long head of the triceps and the lateral head of the triceps, so that the signals can be more distinct.

"It's the kind of operation where you have to adapt when necessary, such as when the muscles needed are missing, muscles from other locations can be transplanted," said Dr. Chao. "For example, leg muscles can be transferred to the upper extremity. One of the bigger advances in this surgery is the use of free flaps to increase those numbers of muscles. Each amputation is different. Some are traumatic like John's. Sometimes muscles are literally ripped out. Sometimes you have to bring a free-flap in to replace other muscles.

Dr. Chao has now completed several TMR surgeries and has patients waiting evaluation. According to Dr. Chao, almost every amputee is a candidate for TMR surgery as long as the brachial plexus is intact and the patient is motivated (functional and wanting to learn how to retrain his muscles.)

"In reality, TMR surgery should be something that we do every week on patients," said Dr. Chao. "There are thousands of patients out there who don't know that we have this operation available to them, not only for the improving bionic arm but for nerve pain as well. I would like to emphasize this -- not only should this operation be thought of for improved function but also for the pain.

"Many patients have horrible nerve pain from the original amputation," he explained. "This operation alleviates this because those nerve endings that went nowhere now are directed somewhere else; they have a purpose. When a nerve doesn't have a purpose, it creates a neuroma, and very often a lot of pain for the patient. A happy side effect of this operation is that nagging nerve pain has decreased and it's quite immediate after surgery. Patients are quite happy about that. To me, to decrease somebody's nerve pain is a success in and of itself."