UPDATE ON UPPER EXTREMITY
PROSTHETIC DESIGN
- BIONICS -

Michael Rivlin, MD
Assistant Professor
Rothman Institute,
Thomas Jefferson University
Reverse engineering

Problem (pathology)

Normal (physiology)

Solution (bionics)
Take home points:

- Not everything is salvageable...
- There are other options
- As surgeons of the extremities we influence the options
Why prosthetics?
Prosthetic workshop
Orthopod: Can we help you?
Vein grafts for venous reconstruction
The Dilemma
Upper extremity prosthetic DESIGN:

Mechanical force ➔ Mechanical gross motor function
Gottfried "Götz" von Berlichingen (1480 – 23 July 1562) also known as Götz of the Iron Hand designed the first known moving prosthesis capable of multiple functions.
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Harness design – first functional prostheses

- Body powered
- Minimal versatility
Upper extremity prosthetic DESIGN:

Muscle electrical activity $\rightarrow$ Mechanical gross motor function
Myoelectrics - since the 1960’s

- uses electromyography signals or potentials from voluntarily contracted muscles
- Controls closing and opening of distal attachment
- often rejected due to the significant neuromuscular retraining required and, even under the best circumstances, the cumbersome, sequential manipulation of each joint or device
Targeted muscle reinnervation (TMR)

- motor nerves whose primary target muscle groups have been lost are re-implanted into deliberately denervated proximal muscles

Advantages:

- Increased number of independent control sites
- intuitively
- simultaneously, rather than sequentially, manipulate multiple joints or devices
1. NEURAL SIGNALS STILL EXIST
2. AVAILABLE MUSCLE SITES
3. INTUITIVE CONTROL

TARGETED REINNERVATION
Targeted muscle reinnervation in the initial management of traumatic upper extremity amputation injury.
Cheesborough JE1, Souza JM1, Dumanian GA2, Bueno RA Jr3.
Targeted muscle reinnervation in the initial management of traumatic upper extremity amputation injury.
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Following TMR procedures at Northwestern Memorial Hospital, five out of nine shoulder disarticulation patients who reported neuroma pain prior to their TMR procedure reported no neuroma pain after TMR.
Upper extremity prosthetic DESIGN:

Muscle pattern activity \rightarrow Mechanical FINE motor function
Advanced pattern recognition (APR)

- computer algorithms to decipher surface electrode data
- and subsequently associate specific signal patterns with
- Requirement: have undergone TMR
The patient factor ... everyone is different

Sorry dude...
THE FUTURE
Function
Osteointegration

- An emerging surgical technique for direct skeletal attachment of prostheses which may one day render sockets antiquated and obsolete for many patients.

- Permanent coupling of metallic implants to the skeleton.

- Works for OMFS, dental implants... ortho?

Tillander CORR 2010
A novel osseointegrated percutaneous prosthetic system for the treatment of patients with transfemoral amputation: A prospective study of 51 patients.

Bränemark R*, Berlin O, Hadberg K, Bergh P, Gunterberg B, Rydevik B.
New horizons

iLimb - Touch Bionics: Customization of function via iPhone App
Upper extremity prosthetic DESIGN:

Neurological electrical → Precise fine motor function
Experimental implant in motor cortex can grant control of extra (third) arm in primates and in early human experiments.
Targeted Sensory Reinervation
And this band on her arm transmits electric signals to the prosthetic.
Is targeted muscle reinervation the answer?
Paterned TSR

Sensation is felt as if on the hand in the following areas:

1. First digit
2. First and second digit
3. Third digit
4. Fourth digit
5. Fifth digit

https://sites.google.com/a/gbcpando.com/targeted-muscle-reinnervation/targeted-sensory-reinnervation
We are not at the finish line yet...

... sometimes it's harder than it looks.
Questions

Thank you