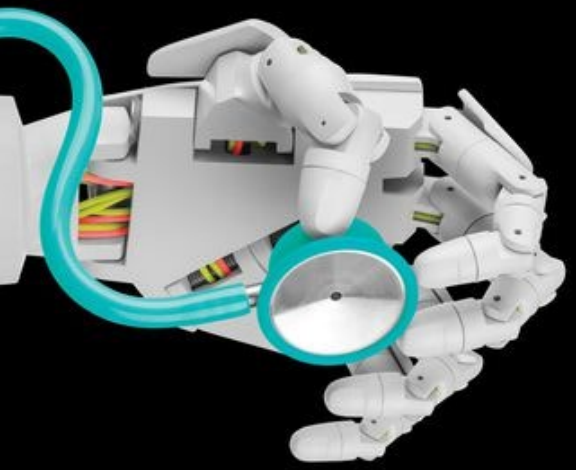
UPDATE ON UPPER EXTREMITY PROSTHETIC DESIGN
- BIONICS -



Michael Rivlin, MD
Assistant Professor

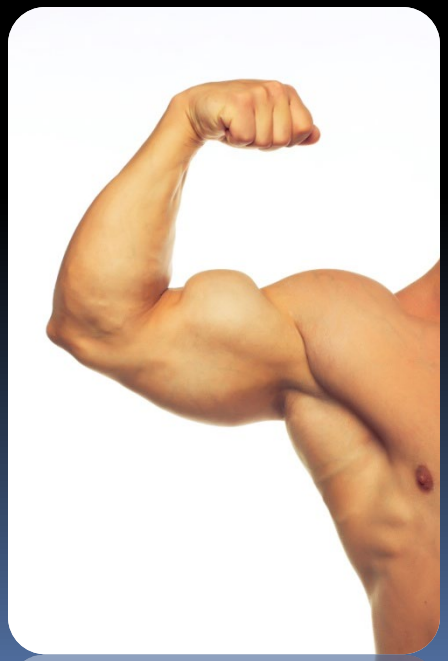
Rothman Institute,
Thomas Jefferson University

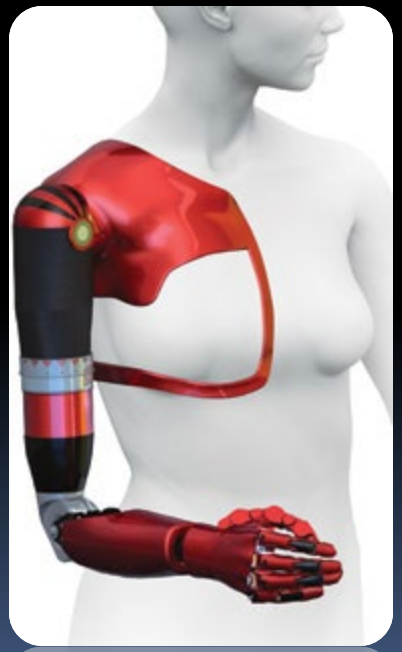
Reverse engineering

Problem (pathology)

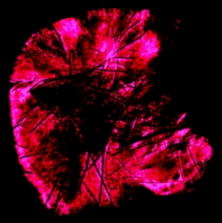
Normal (physiology)

Solution (bionics)





Take home points:

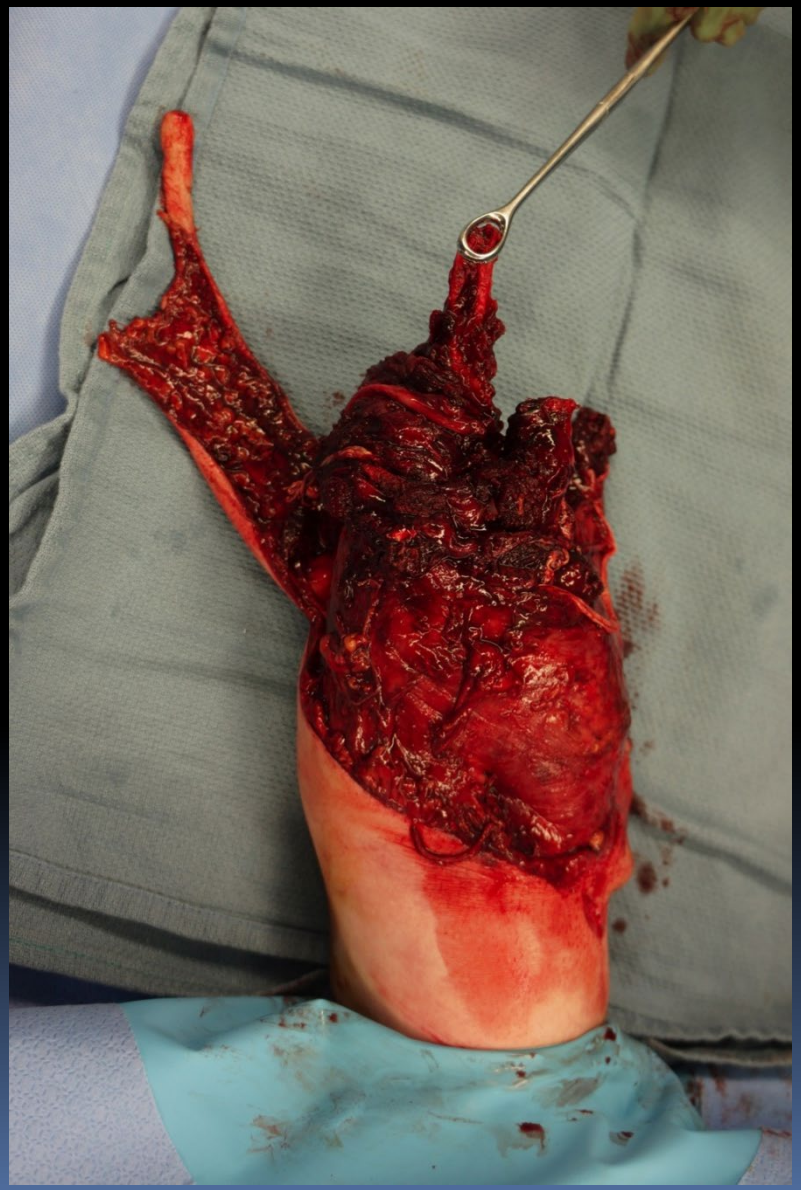


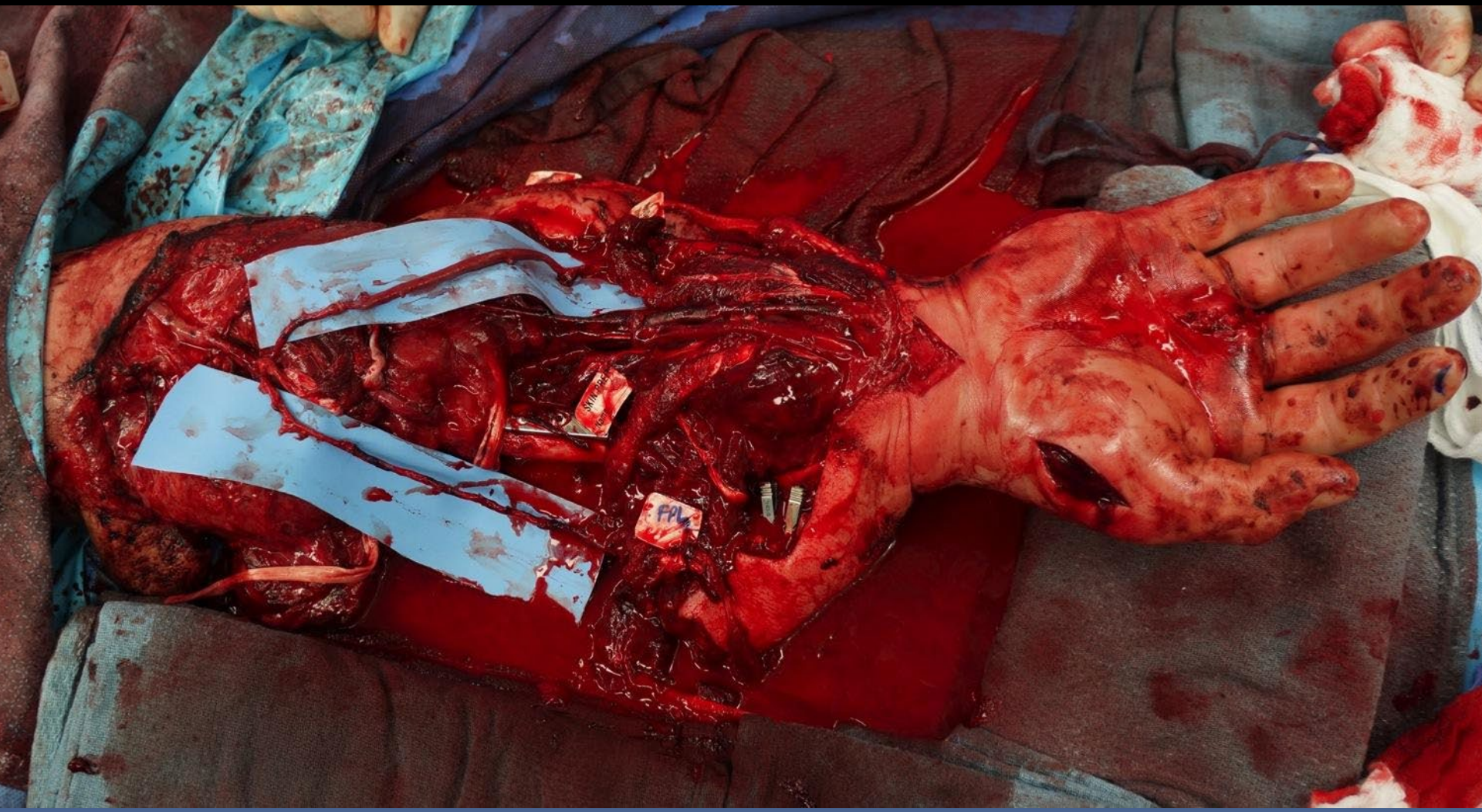
- Not everything is salvageable…
- There are other options
- As surgeons of the extremities we influence the options

Why prosthetics?

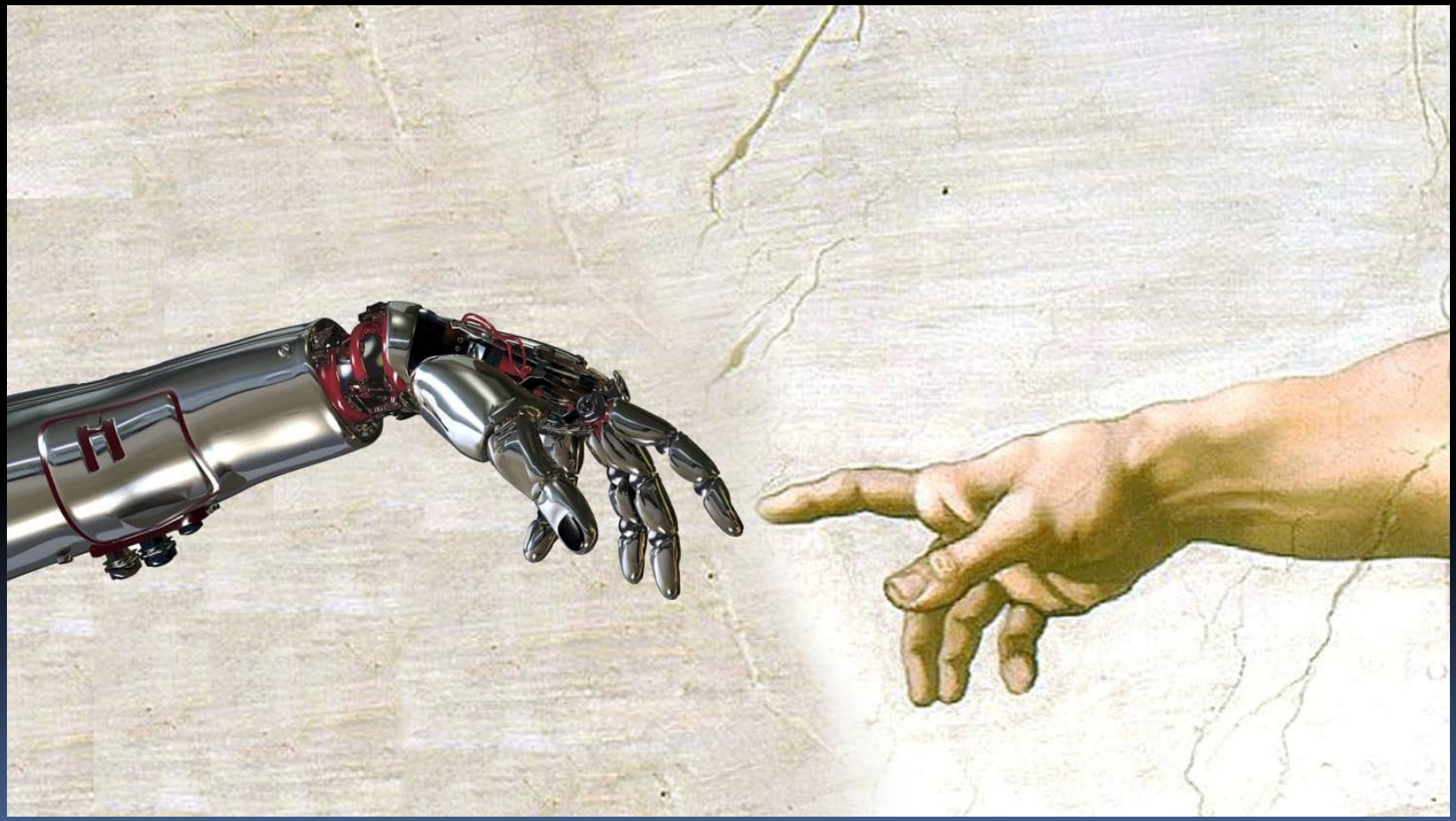
Prosthetic workshop

Orthopod: Can we help you?




FPL

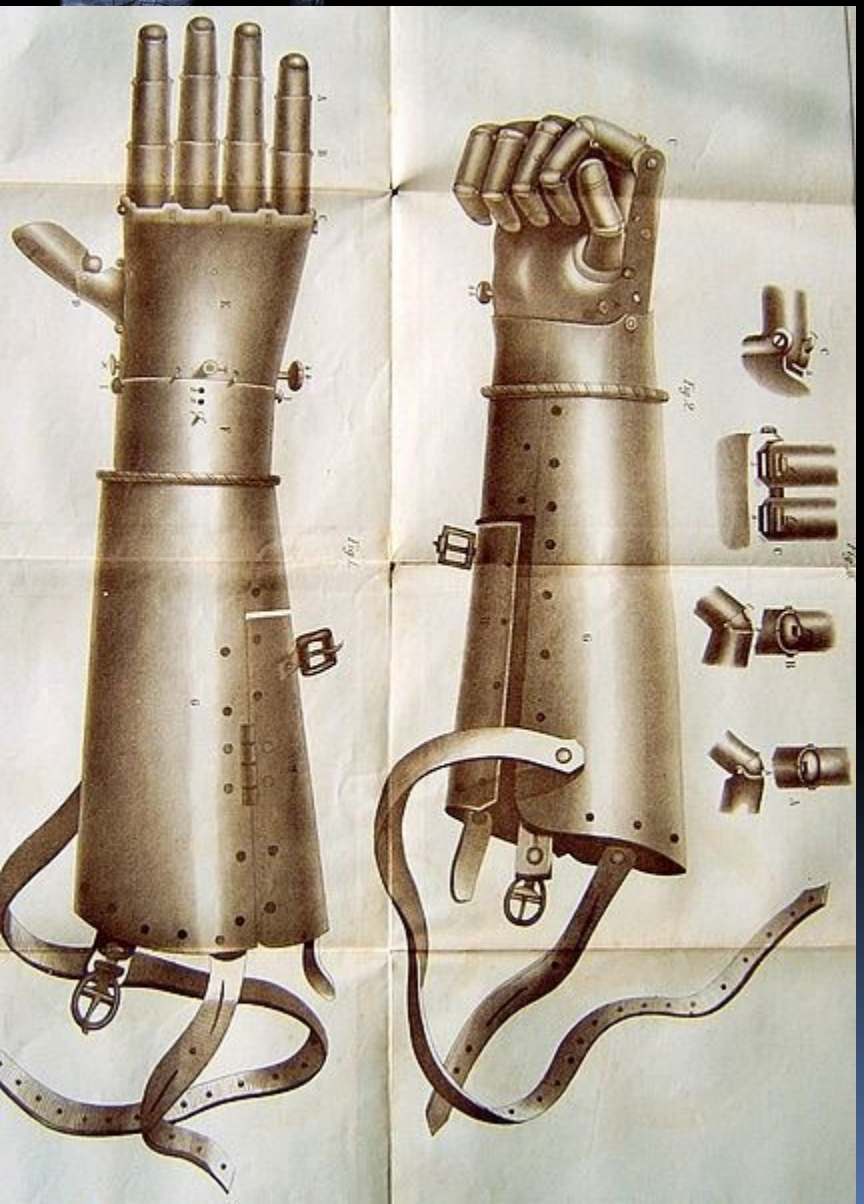
The Dilemma



Upper extremity prosthetic DESIGN:

Mechanical force → Mechanical gross motor function

First Mobile Hand Prosthesis



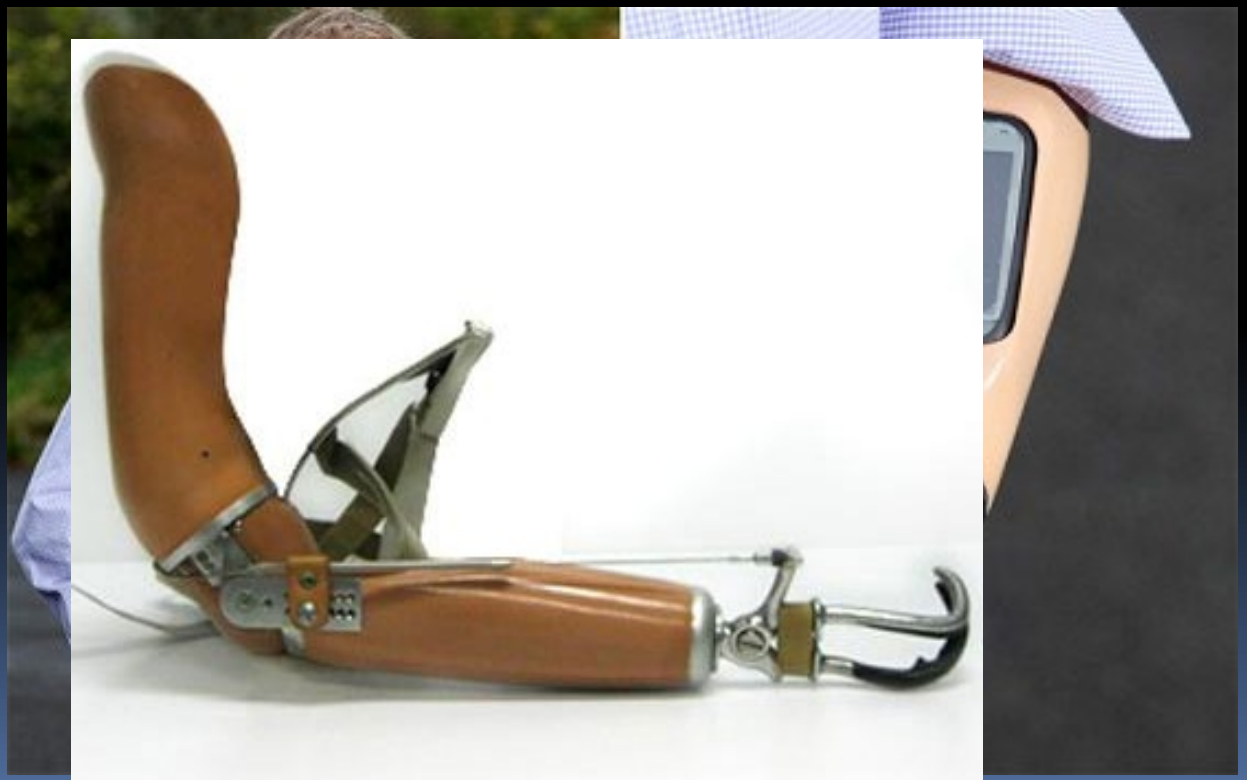
Gottfried "Götz" von Berlichingen (1480 – 23 July 1562) also known as **Götz of the Iron Hand** designed the first known moving prosthesis capable of multiple functions

First Mobile Hand Prosthesis

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

Harness design – first functional prostheses

- Body powered
- Minimal versatility

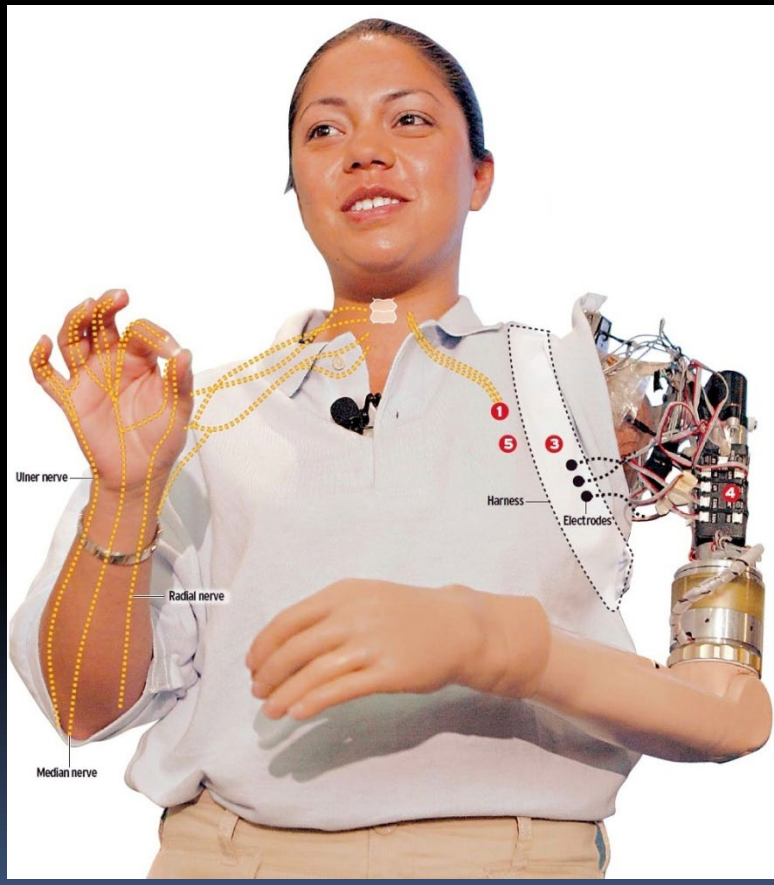


Upper extremity prosthetic DESIGN:

Muscle electrical activity → Mechanical gross motor function

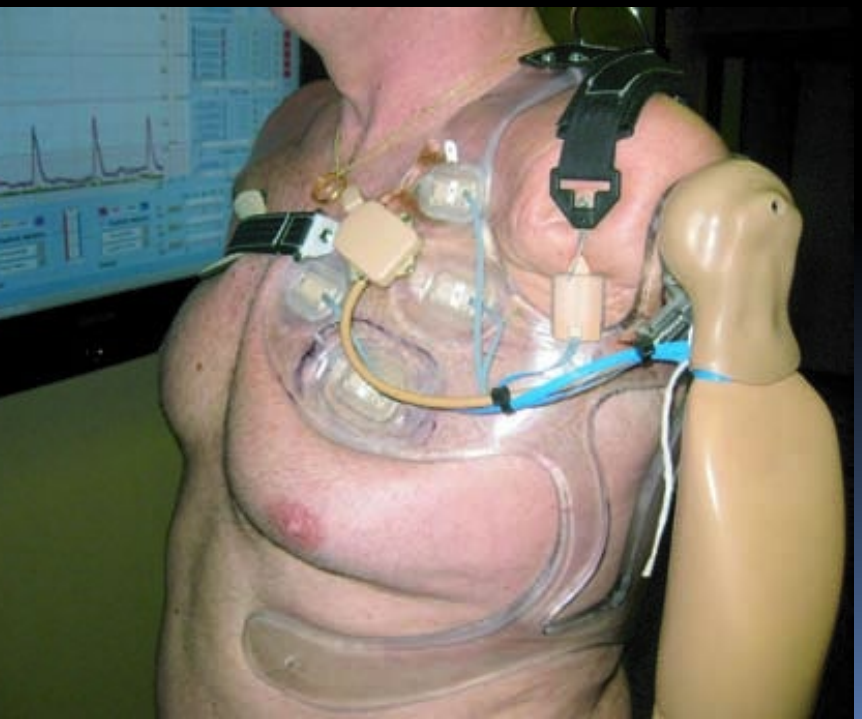
Myoelectrics - since the 1960's

- 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



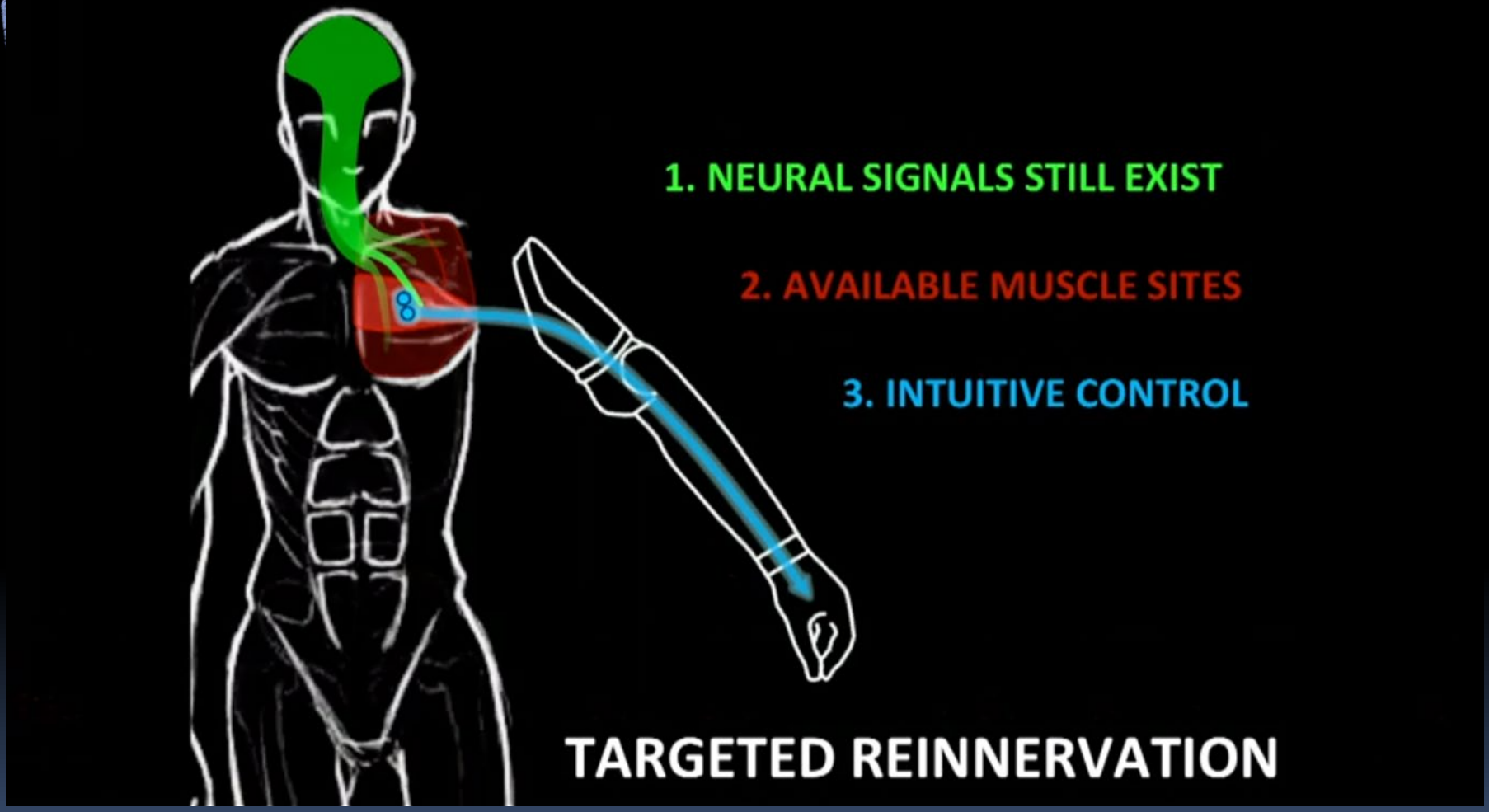
Targeted muscle reinnervation (TMR)

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

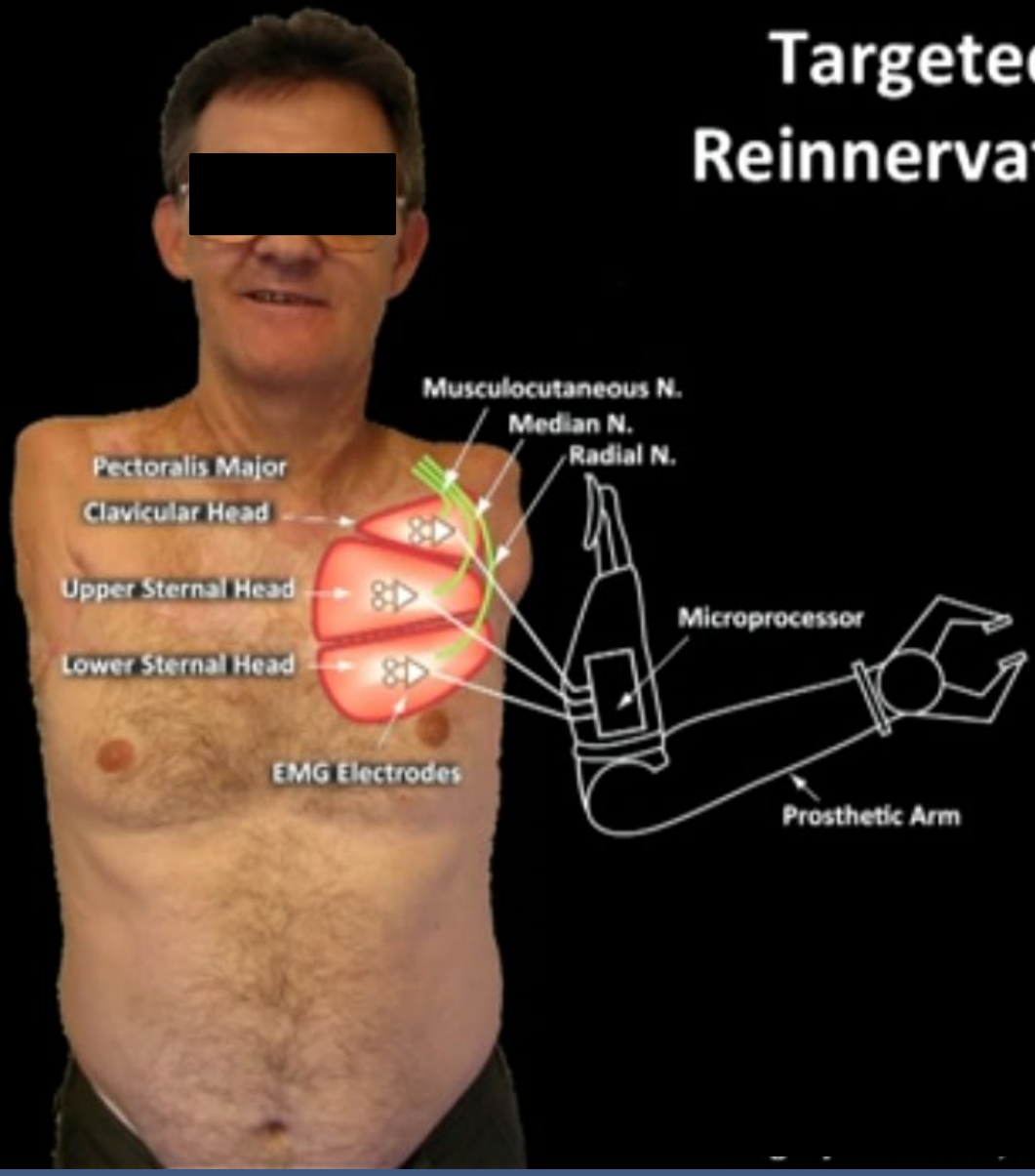


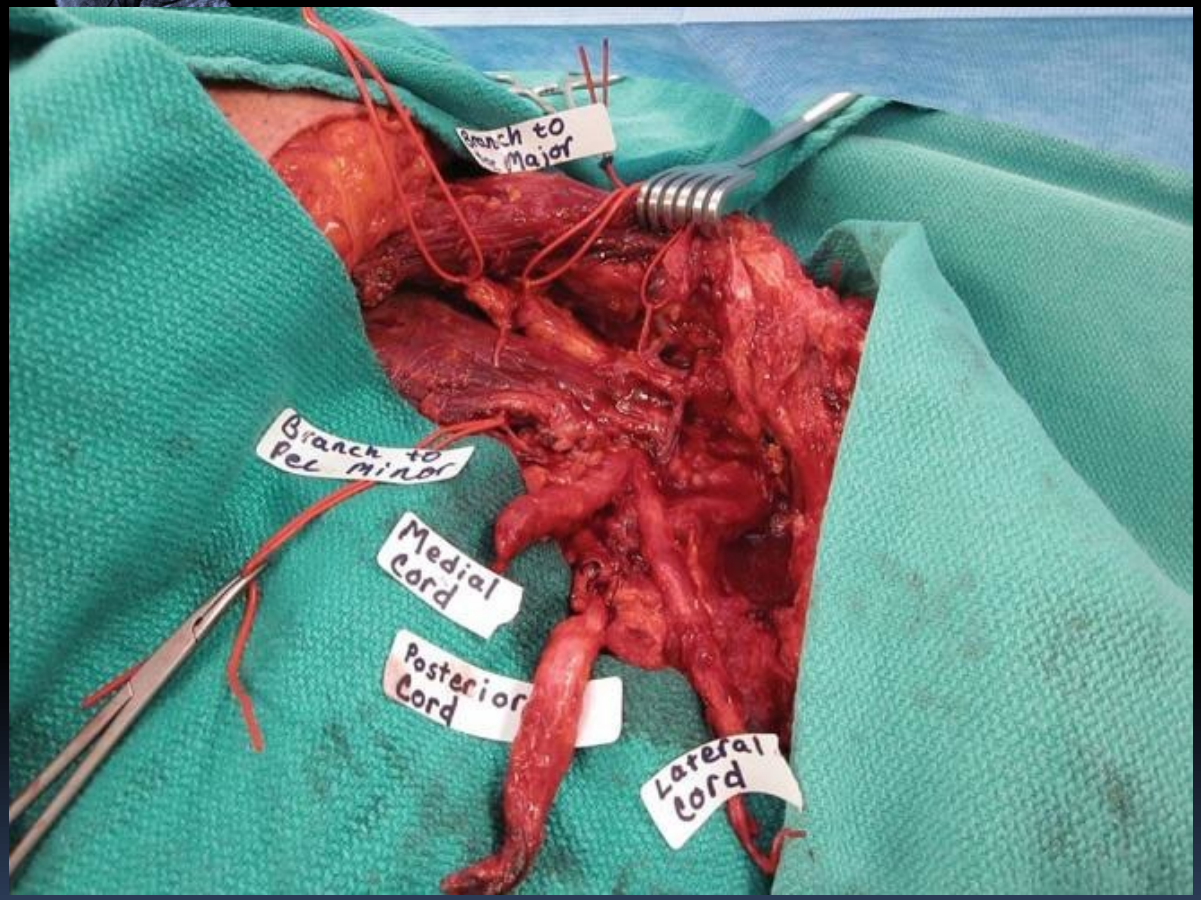
Advantages:

- Increased number of independent control sites
- intuitively
- simultaneously, rather than sequentially, manipulate multiple joints or devices

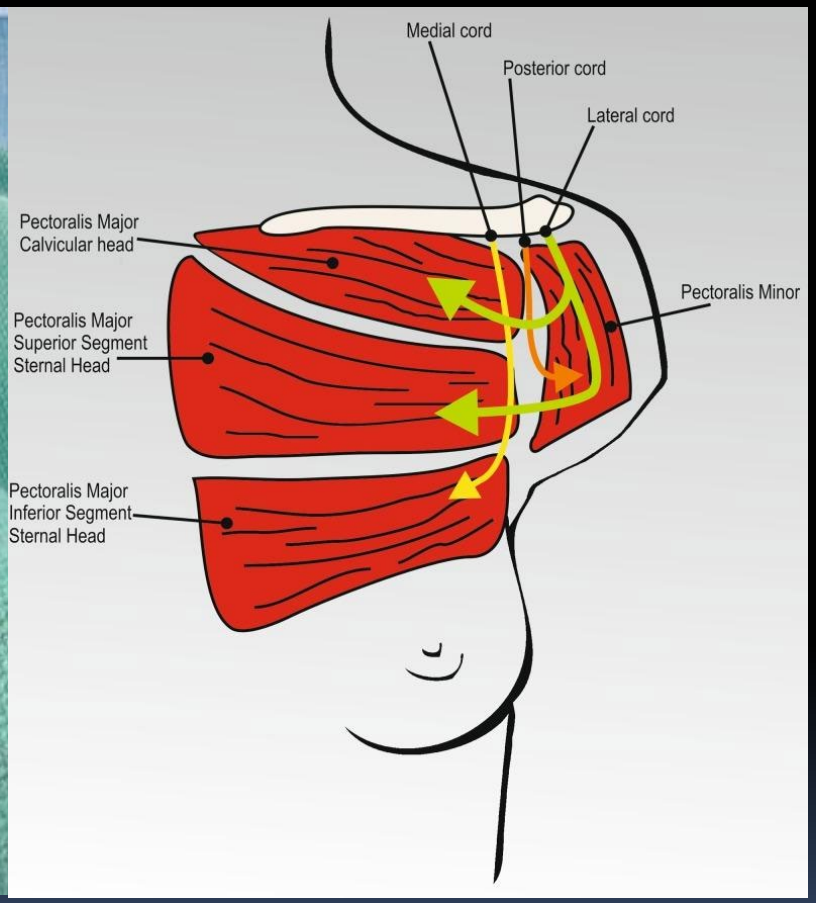

1. NEURAL SIGNALS STILL EXIST
2. AVAILABLE MUSCLE SITES
3. INTUITIVE CONTROL
TARGETED REINNERVATION

Targeted Reinnervation





Hand (N Y). 2014 Jun;9(2):253-7. doi: 10.1007/s11552-014-9602-5.
Targeted muscle reinnervation in the initial management of traumatic upper extremity amputation injury.
Cheesborough JE1, Souza JM1, Dumanian GA2, Bueno RA Jr3.



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ALSO

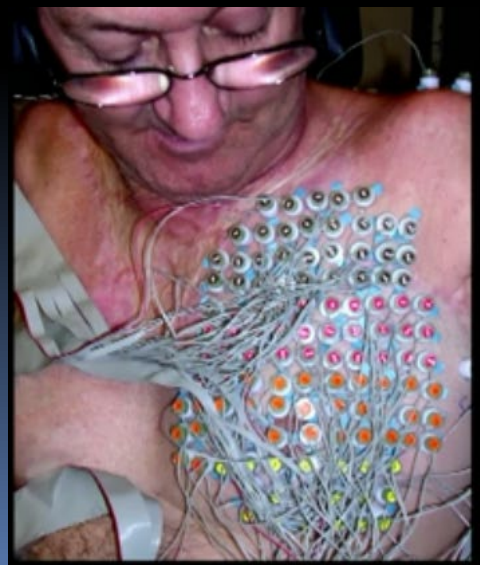
- Following TMR procedures at Northwestern Memorial Hospital, five out of nine shoulder disarticulation patients who reported neuroma pain prior to their TMR procedure reported no neuroma pain after TMR.

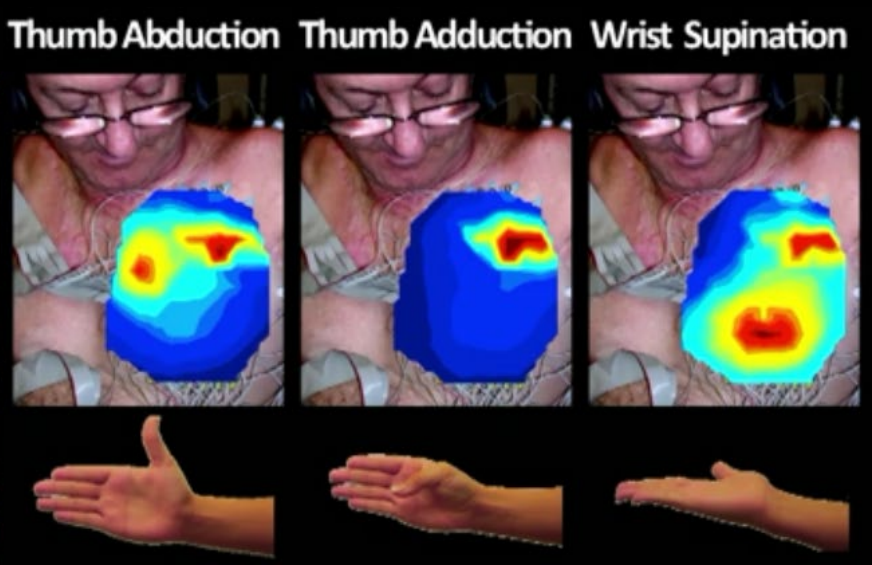
Upper extremity prosthetic DESIGN:

Muscle pattern activity → Mechanical FINE motor function

Advanced pattern recognition (APR)

- computer algorithms to decipher surface electrode data
- and subsequently associate speciffic signal patterns with
- Requirement: have undergone TMR

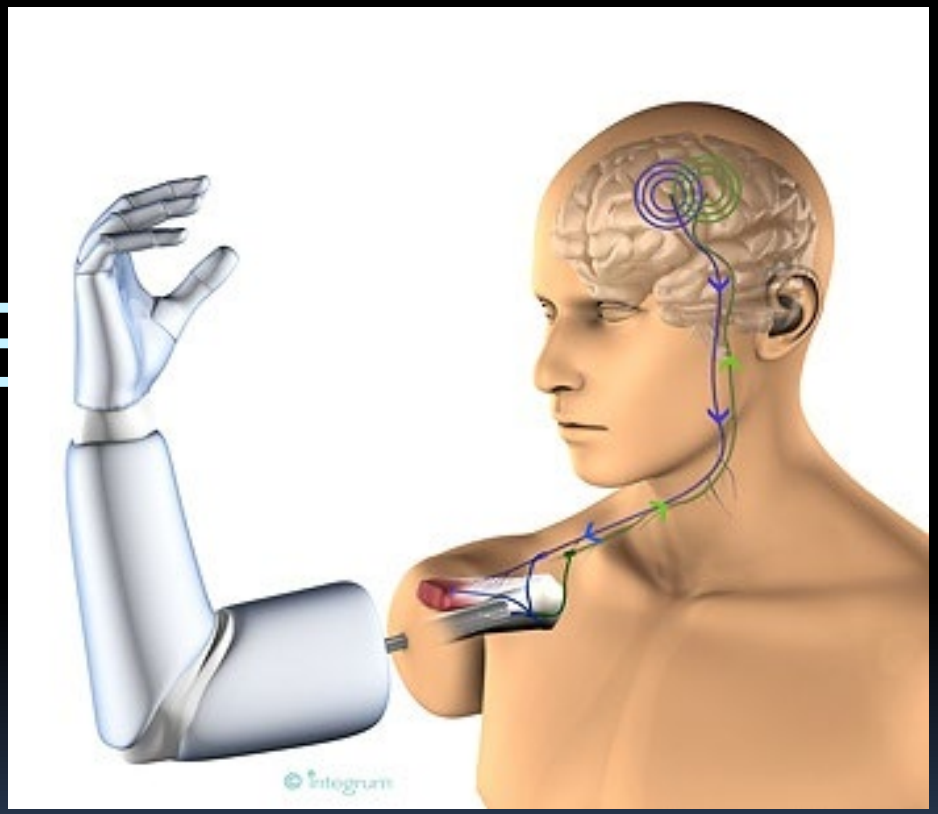




1

The patient factor …
everyone is different

THE FUTURE



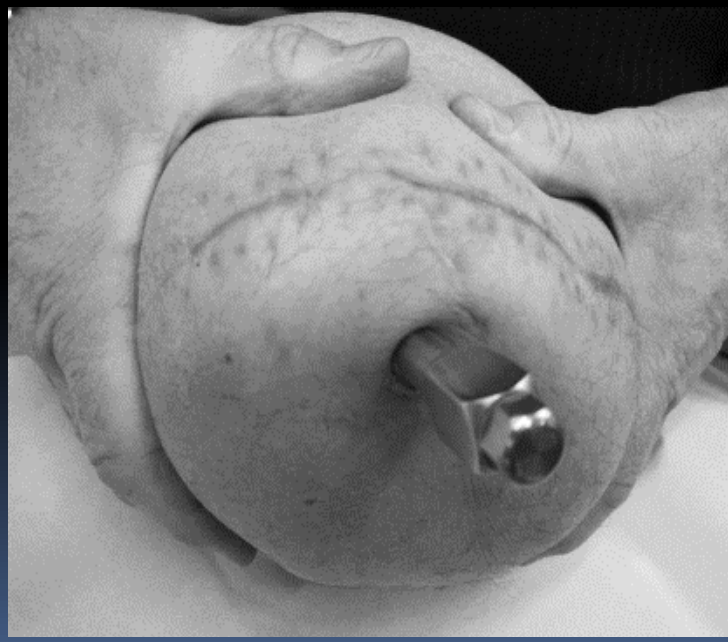
Function

2

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?



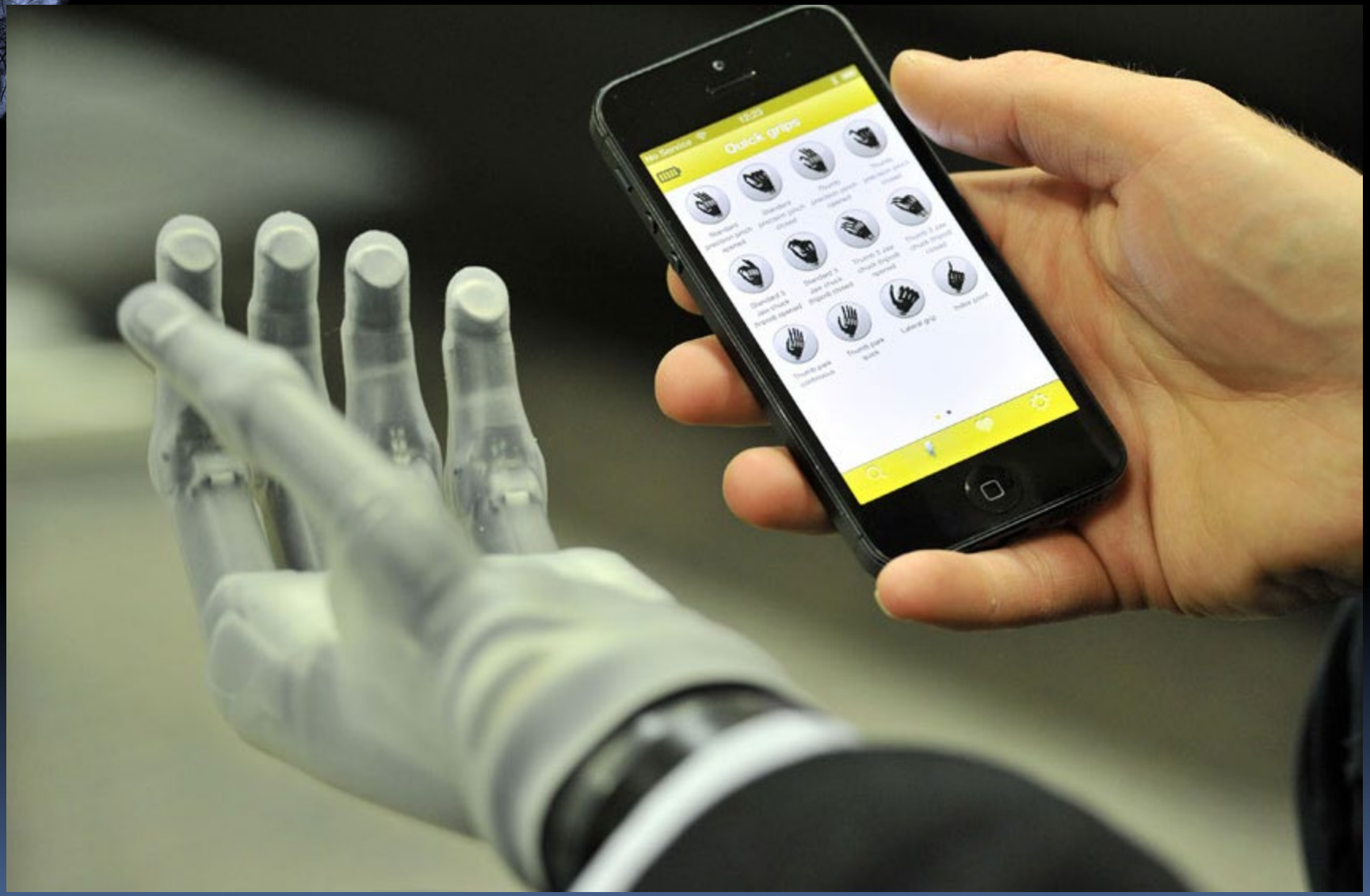
Branemark , J. Rehabil. Res. 2001
Tillander CORR 2010

Osseointegrated percutaneous prostheses

Survival rate at two years (92%)
enhanced prosthetic use and mobility,
fewer problems and improved quality of life

A novel osseointegrated percutaneous prosthetic system for the treatment of patients with transfemoral amputation: A prospective study of 51 patients.
Brånemark R[1], Berlin O, Hagberg K, Bergh P, Gunterberg B, Rydevik B.
Bone Joint J. 2014 Apr;96-B(4):562.

New horizons



iLimb - Touch Bionics: Customization of function via iPhone App

Upper extremity prosthetic DESIGN:

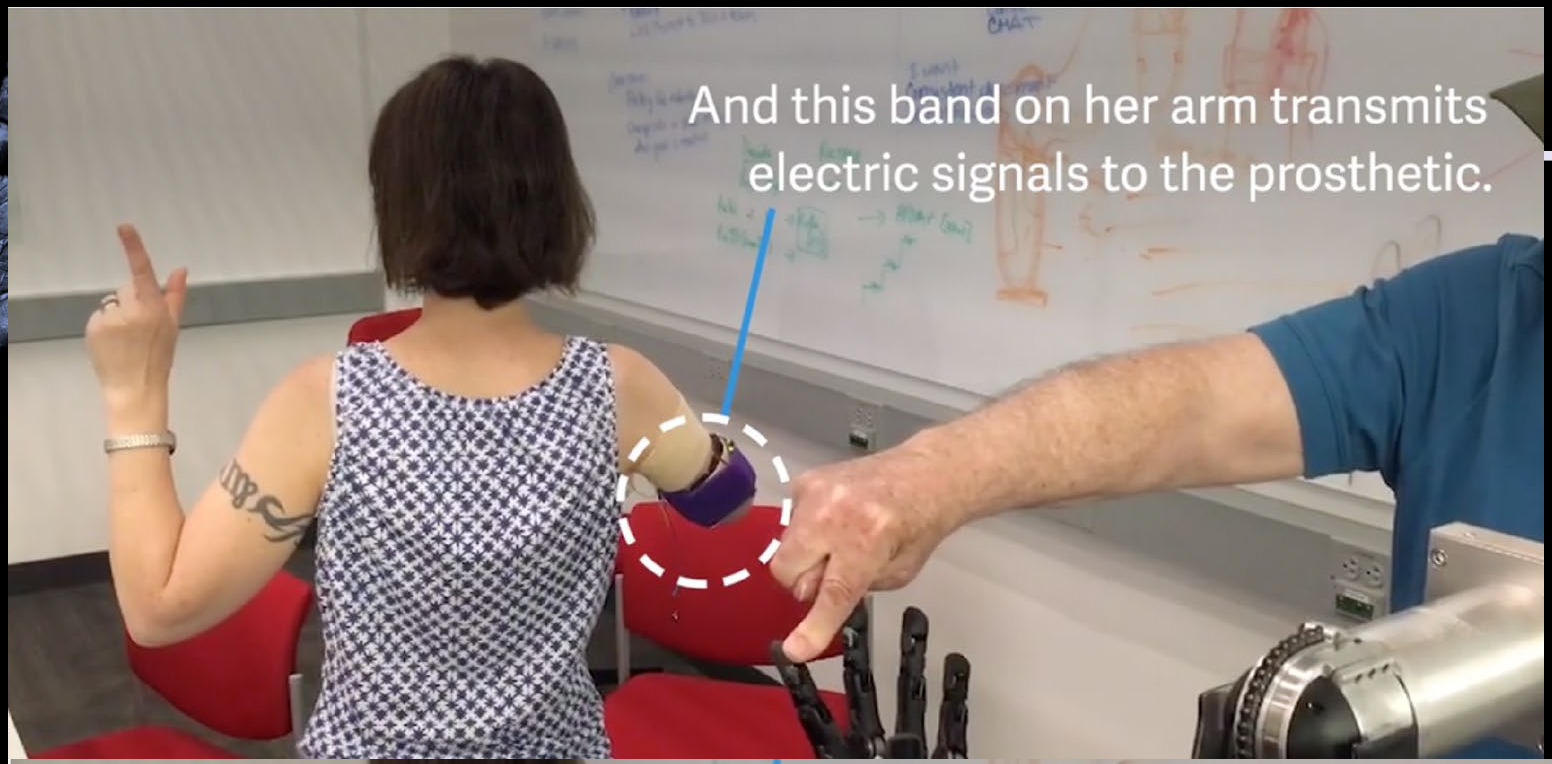
Neurological electrical → Precise fine motor function

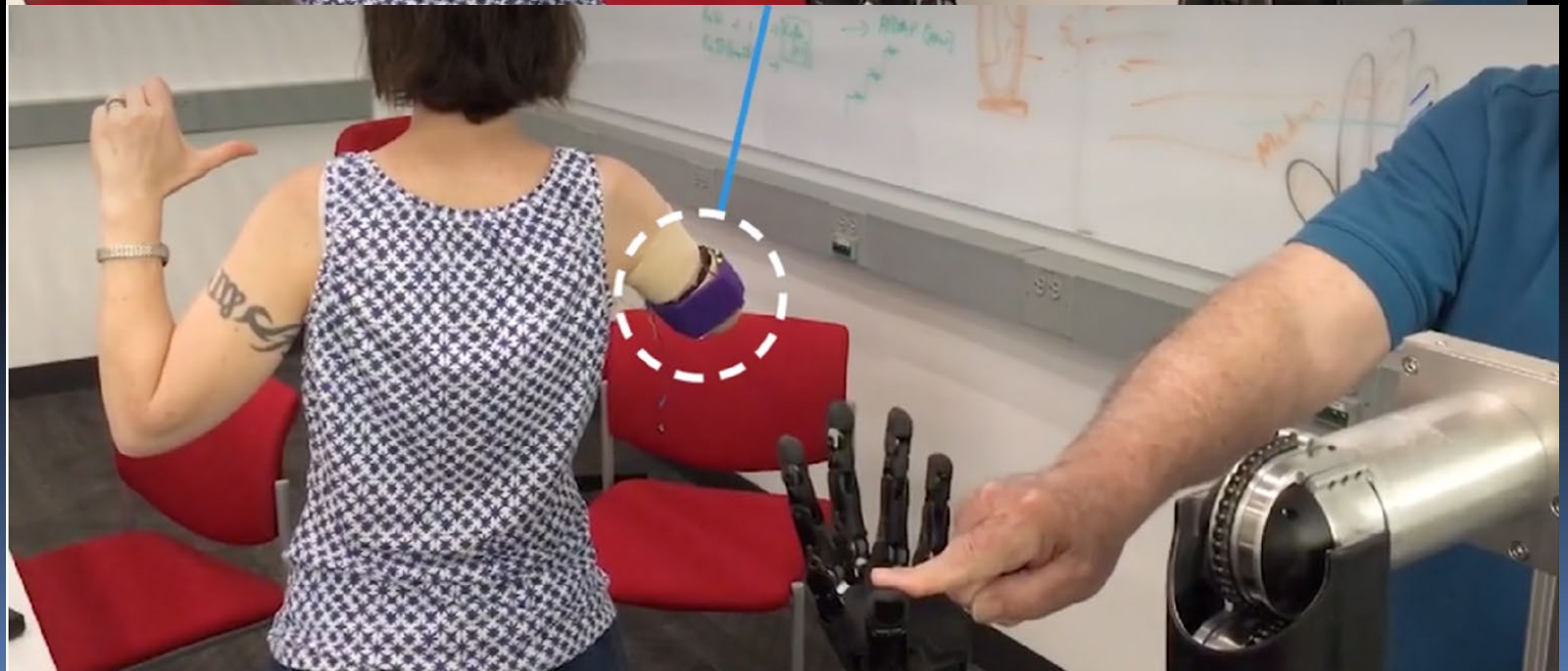
Intuitive control – with CNS

Experimental implant in motor cortex can grant control of extra (third) arm in primates and in early human experiments

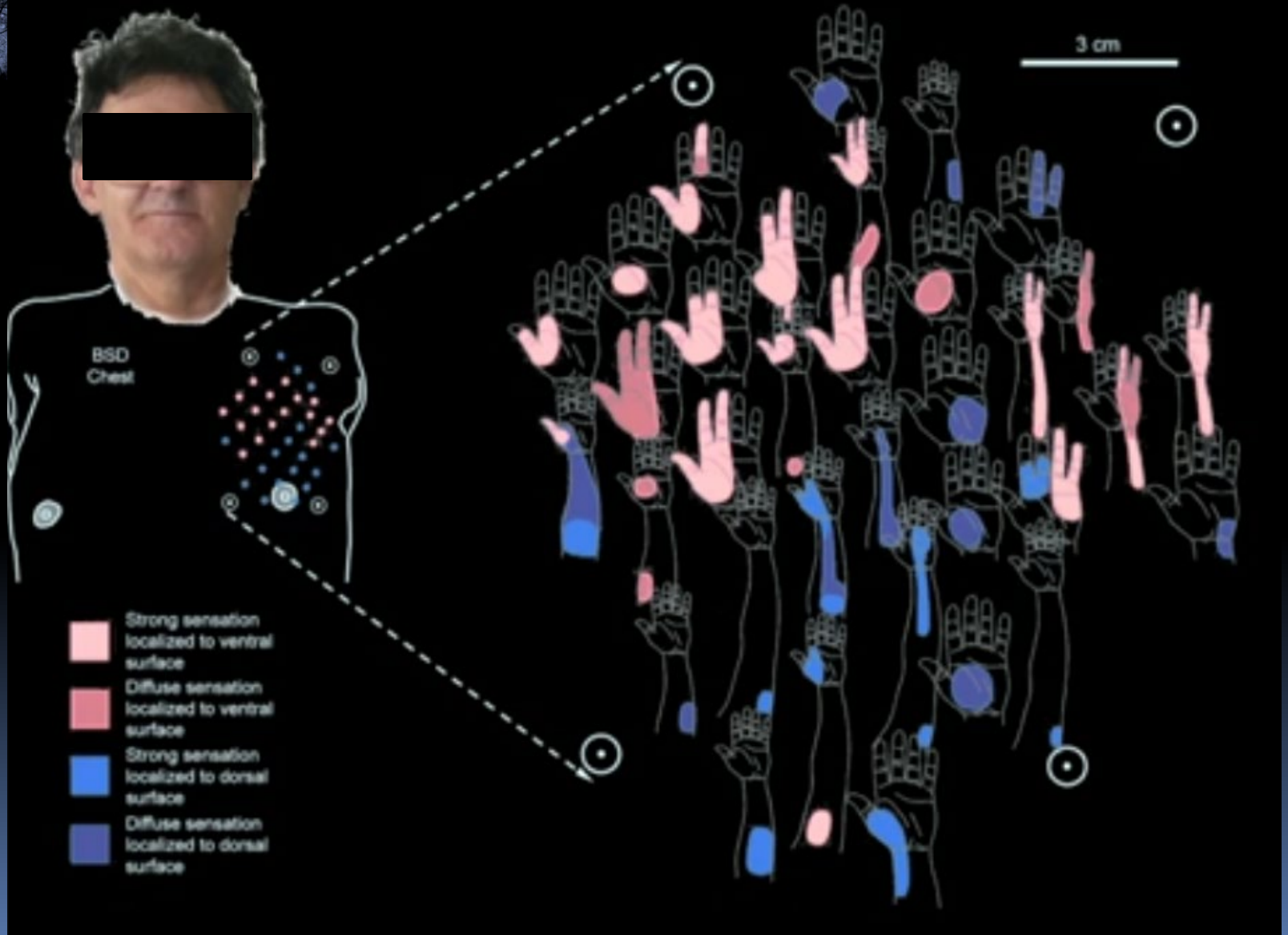
3

Targeted Sensory Reinervation

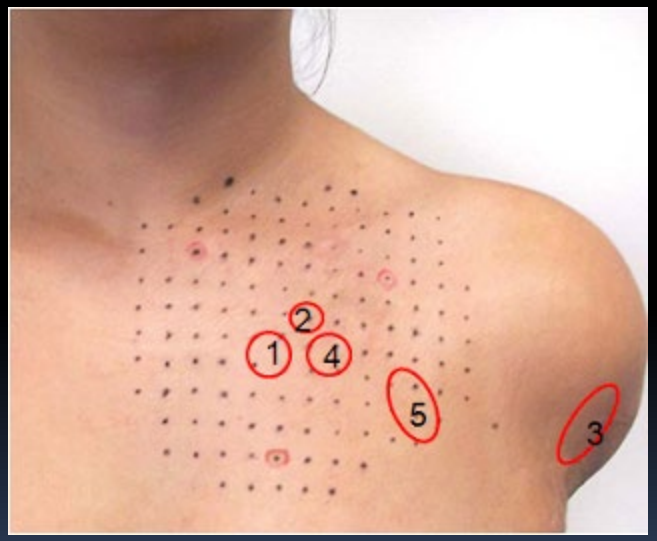

And this band on her arm transmits
electric signals to the prosthetic.



Sensation


BSD
Chest
3 cm
Strong sensation localized to ventral surface
Diffuse sensation localized to ventral surface
Strong sensation localized to dorsal surface
Diffuse sensation localized to dorsal surface

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 its harder than it looks

Questions

Thank you