

TMR surgery

UK-based experience

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Why?



Why?



Why?

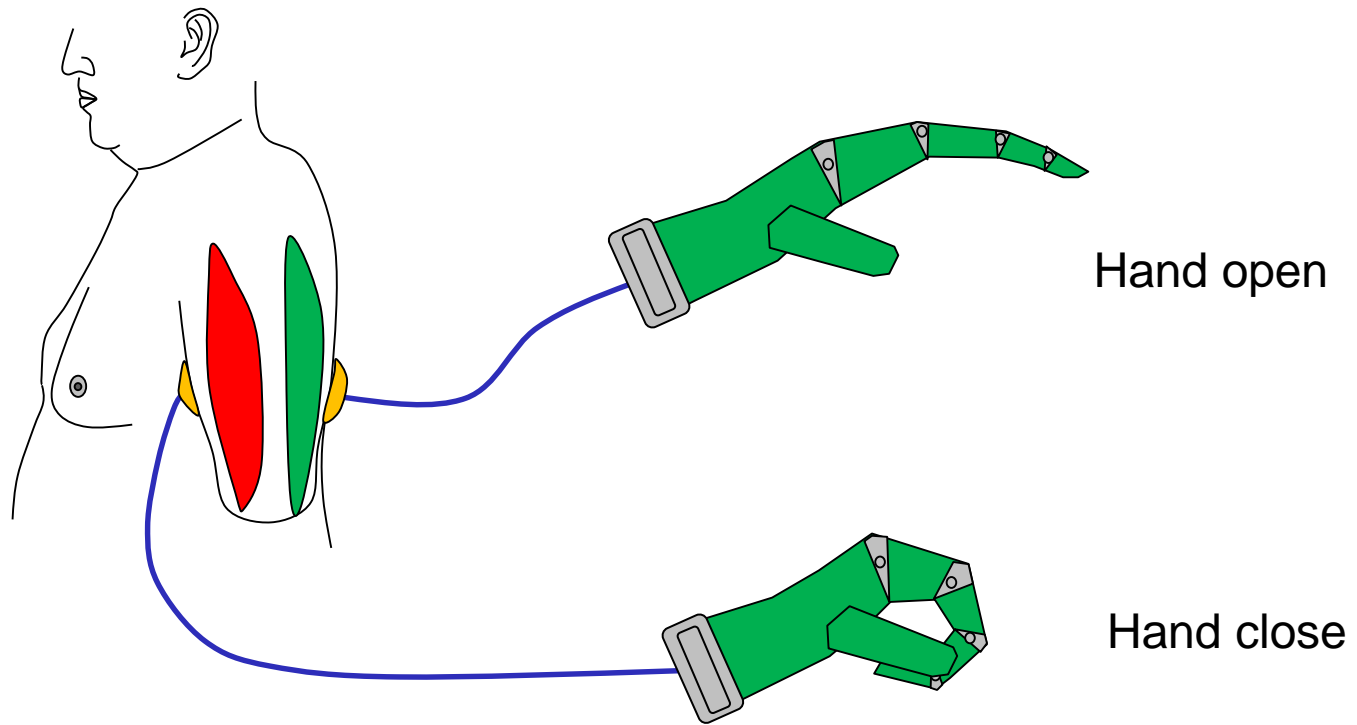


Regular user of cable-operated prosthesis

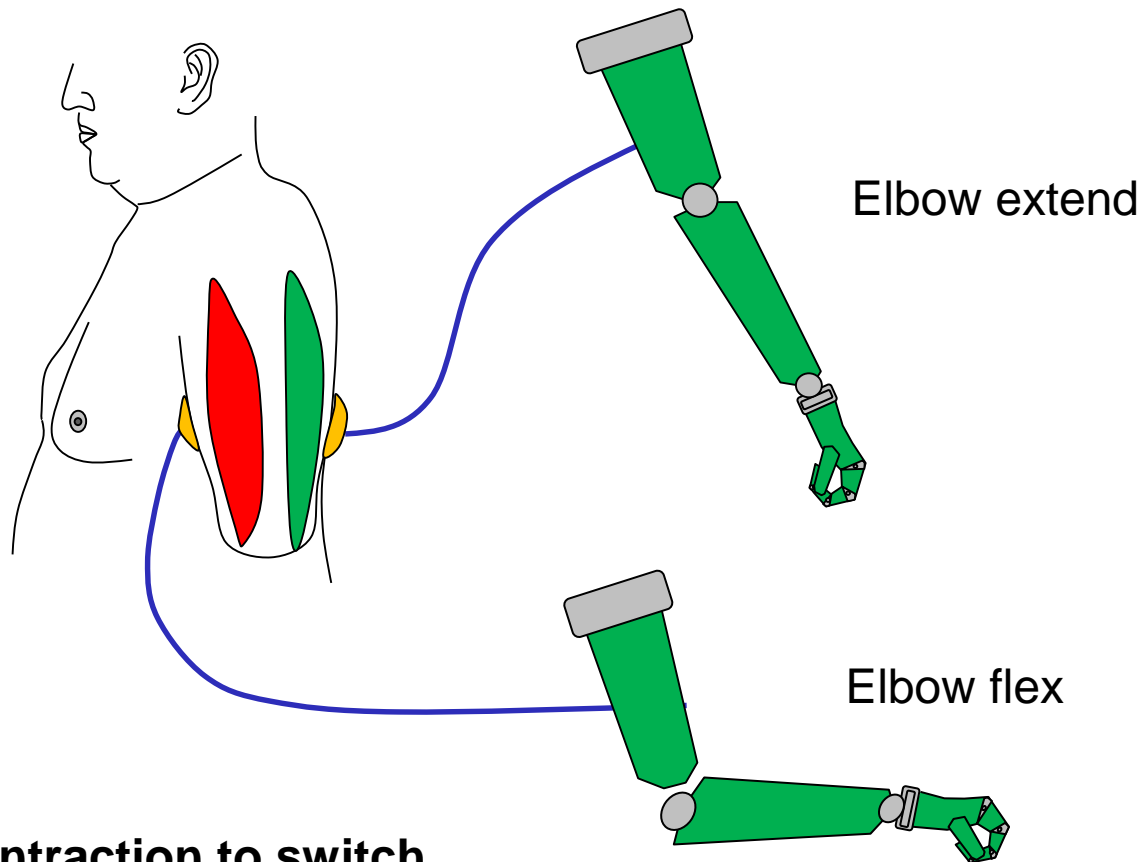
Why?

control

Conventional Myoelectric Prosthesis



Conventional Myoelectric Prosthesis



With co-contraction to switch

Conventional Myoelectric Prosthesis

Difficulties:

- Not intuitive
- Simultaneous movements impossible
- Actions are slow
- Some patients never learn how to do co-contraction
- Only a few signals
- Surface electrodes move around
- Accidental activation of prosthesis is common

Conventional Myoelectric Prosthesis

To improve control of myoelectrics:

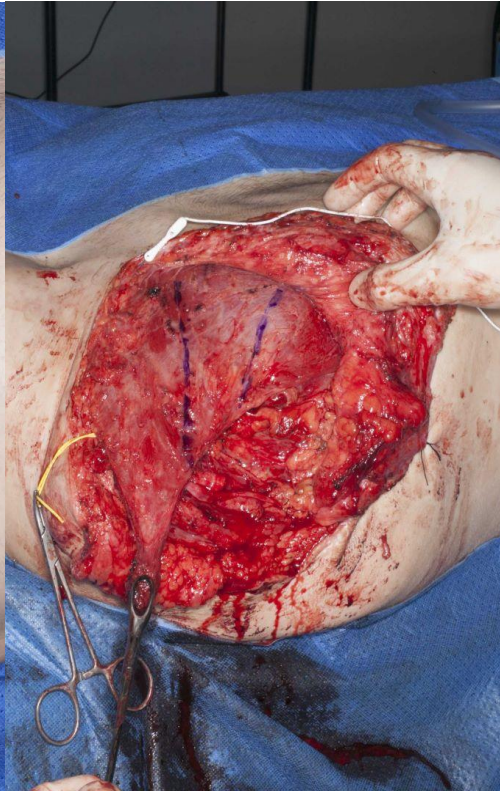
- Direct neural interface (hard to do)
- Pattern recognition (hard to do without TMR)
- Targeted Muscle Reinnervation (Kuiken) -
 - Muscle acts as bio-amplifier
 - Relatively easy to do and understand
 - Makes it easier for pattern recognition
 - Discreet signals

Targeted Muscle Reinnervation

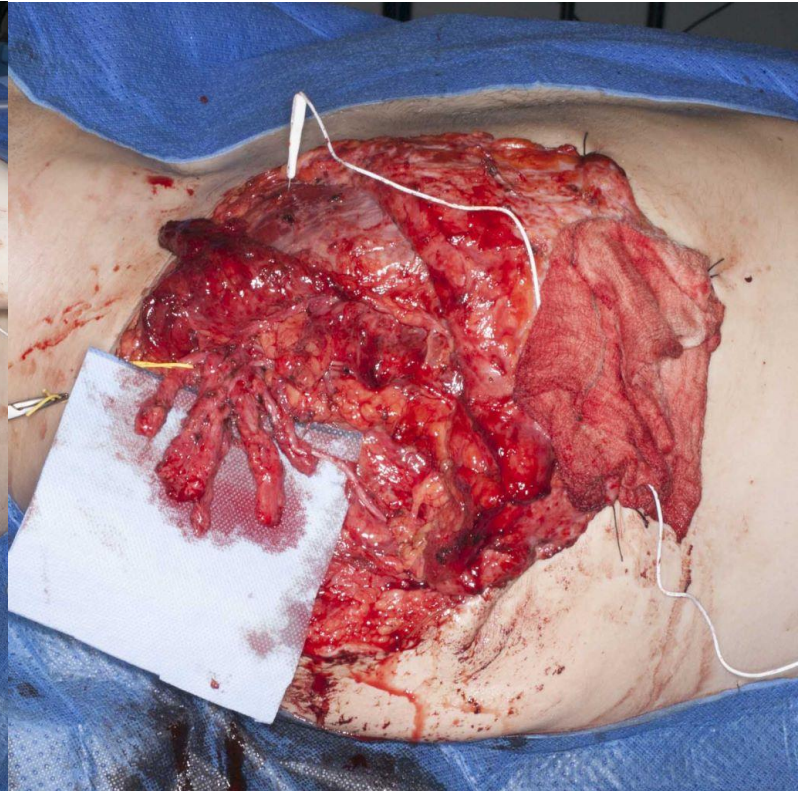
(glenohumeral amputee)



Incisions



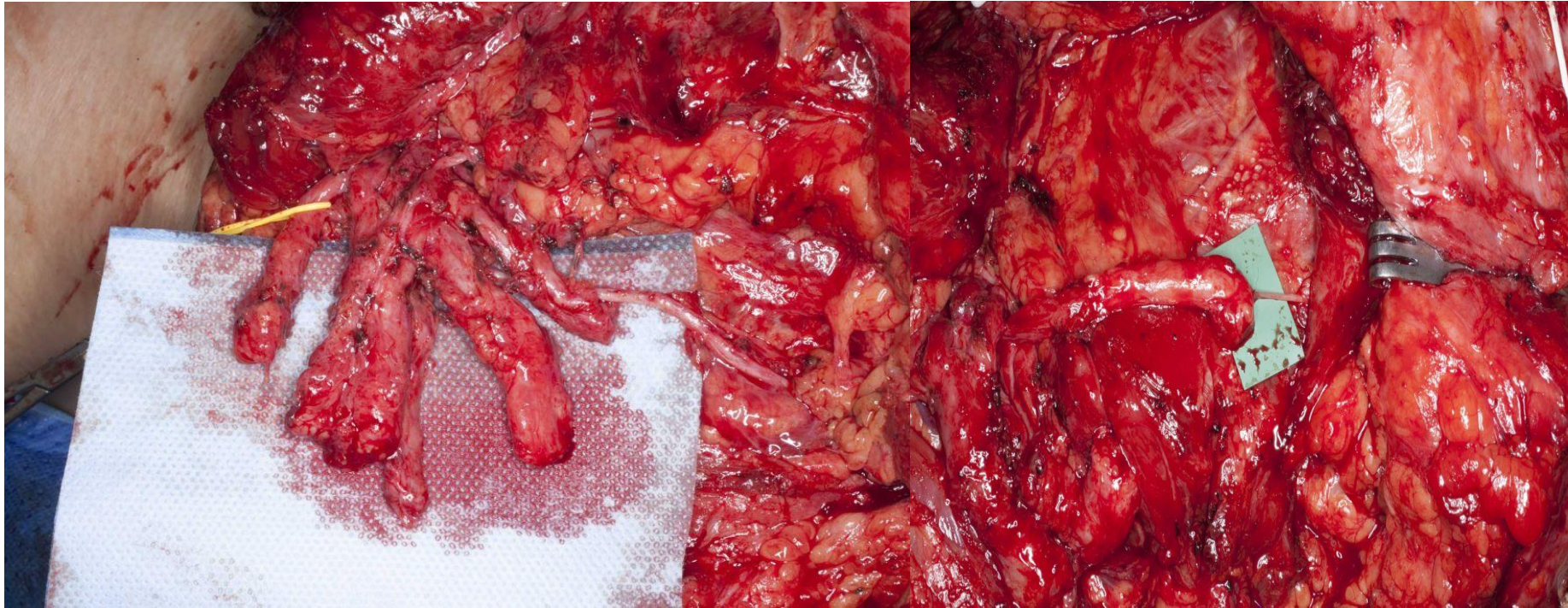
Pectoralis Major
about to be lifted



Components of brachial plexus
separated out

Targeted Muscle Reinnervation

(glenohumeral amputee)



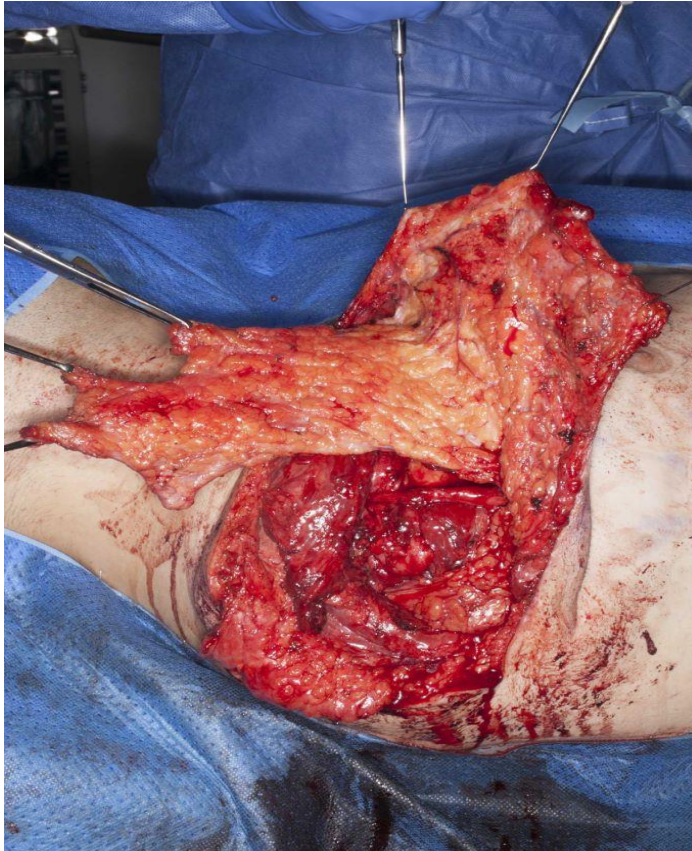
What goes where?!!

Need to know your anatomy

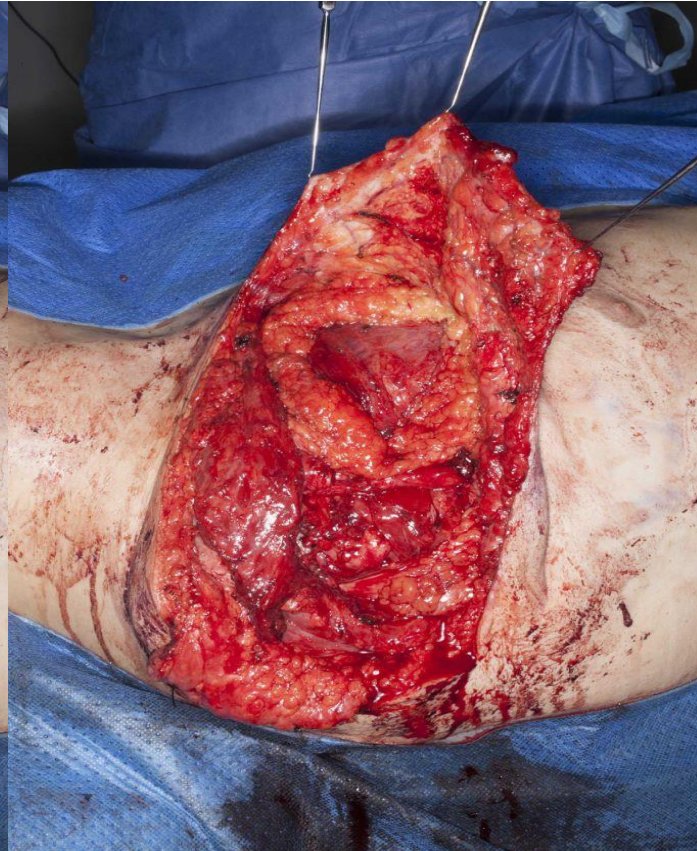
Large discrepancy in size
of brachial plexus nerves
and recipient motor nerves

Targeted Muscle Reinnervation

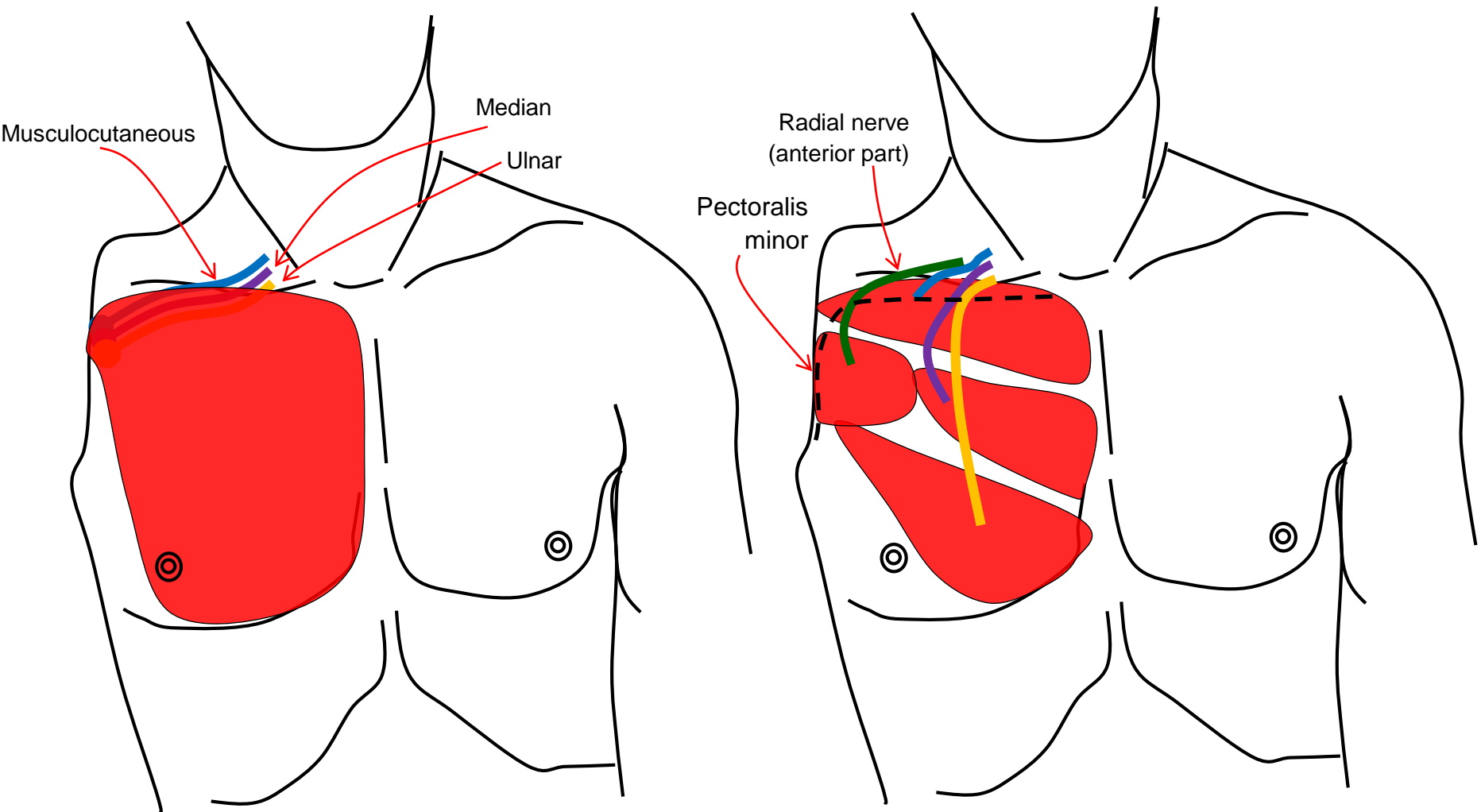
(glenohumeral amputee)



Adipofascial flap for thinning
and electrical insulation

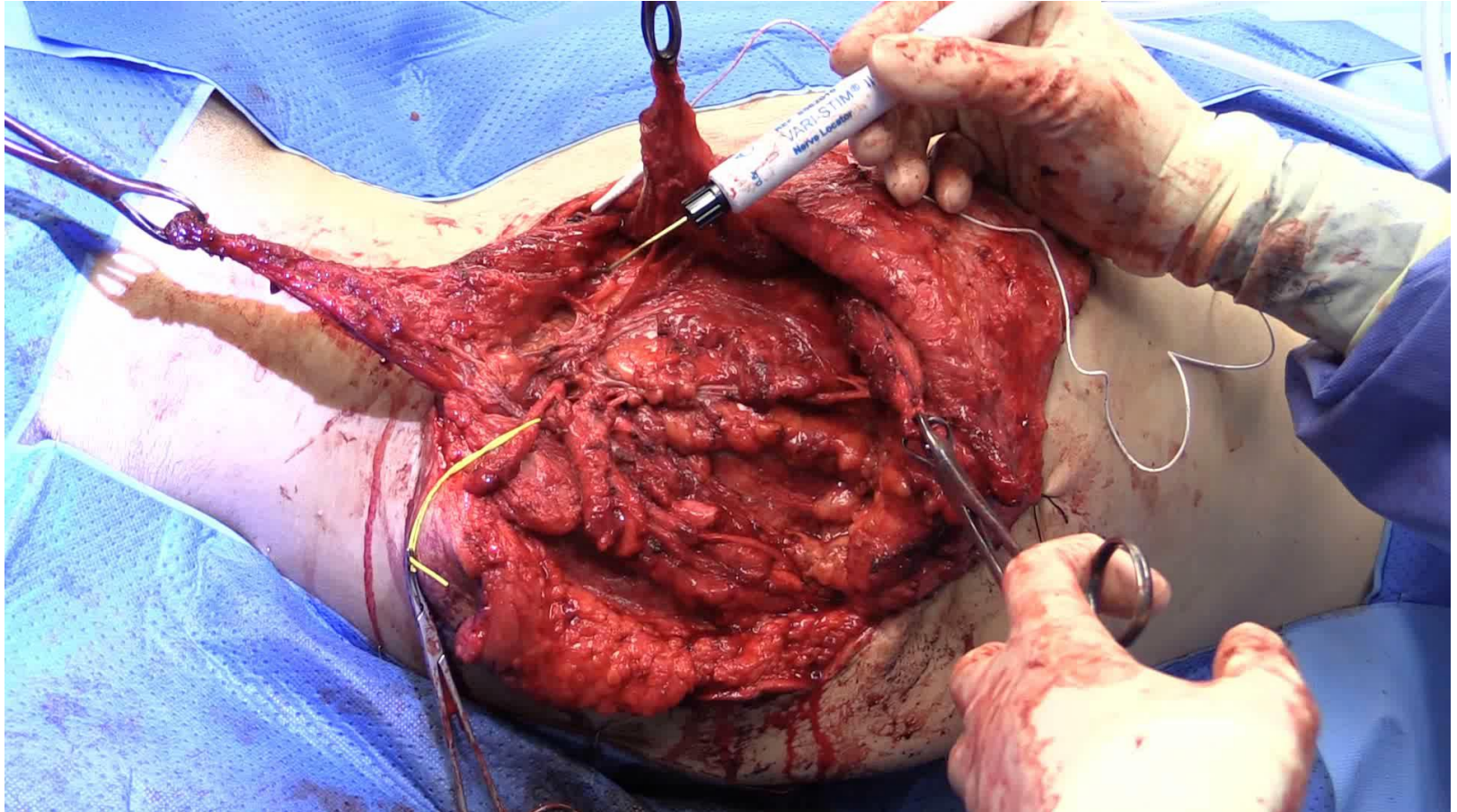


Flap inset around the
muscles

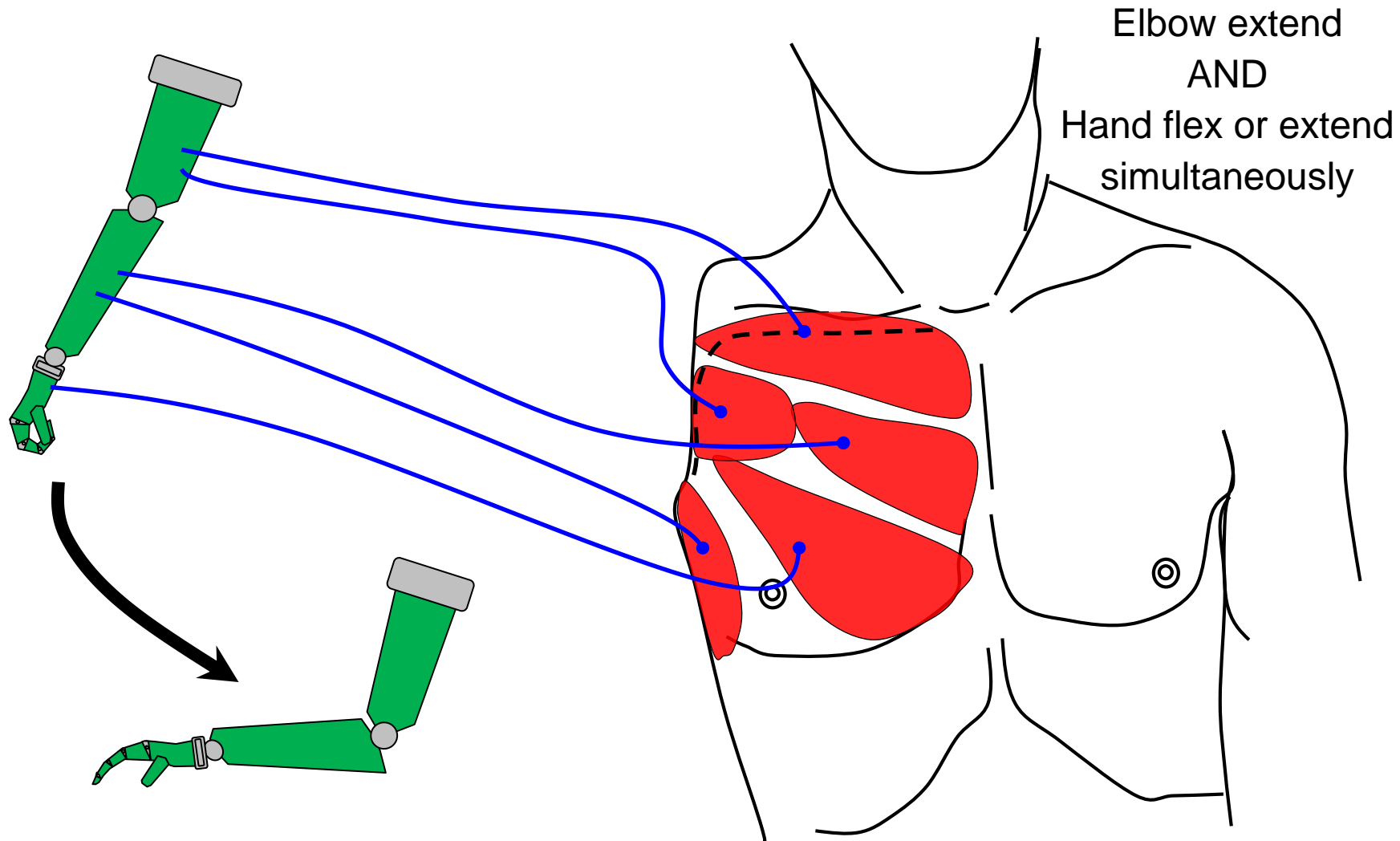


- **Musculocutaneous** to upper pectoralis major end-to-end
- **Median** to middle pectoralis major
- **Ulnar** to lower pectoralis major
- **Posterior part of posterior cord** to lat dorsi
- **Anterior part of posterior cord** to pectoralis minor

Targeted Muscle Reinnervation



Transhumeral amputee



- **Musculocutaneous** to upper pectoralis major end-to-end
- **Median** to middle pectoralis major
- **Ulnar** to lower pectoralis major
- **Posterior part of posterior cord** to lat dorsi
- **Anterior part of posterior cord** to pectoralis minor

TMR



TMR



TMR



Targeted Muscle Reinnervation

Advantages:

- All reinnervated muscles are under intuitive control
- “think hand” = muscle contracts
- “think elbow” = muscle contracts
- Simultaneous movements now possible
- Actions are fast and fluid
- Learning is easier
- Multiple signals – PATTERN RECOGNITION POSSIBLE
- Sensory reinnervation possible
- ? BENEFICIAL FOR PHANTOM LIMB

TMR

Targeted Muscle Reinnervation A Novel Approach to Post-amputation Neuroma Pain

Jason M. Souza MD, Jennifer E. Cheesborough MD, Jason H. Ko MD, Mickey S. Cho MD, Todd A. Kuiken MD, PhD, Gregory A. Dumanian MD

Clin Orthop Relat Res (2014) 472:2984–2990

Of the 15 patients with neuroma pain after amputation, 14 experienced complete resolution of pain in the transferred nerves. However, the other patient experienced such significant improvement in his pain that he was able to be fit

TMR

(UK Experience)

Outcomes:

- All of the patients have had transient increase in PLP
- All of the upper limb have had (eventual) relief from neuroma pain and reduction in PLP
- Most of the lower limb patients had immediate relief of neuroma pain - ?reduction in PLP
- Many patients report **“throwing their pain meds away”**

TMR

(UK Experience)

Why not TMR in the UK?

- 80% of patients with limb-loss experience phantom limb pain (PLP)
- 20 – 30% have disabling neuroma pain
- Drugs bill for chronic pain (not just PLP) considerable
- We should consider TMR for any patient with intractable
 - neuroma pain
 - ?phantom limb pain too
- Improved ability to control prosthesis is then incidental benefit

TMR

(UK Experience)

	PATIENT 1	PATIENT 2	PATIENT 3
TIME TO TMR (YEARS)	8	11	25
ANALGESIA	Paracetamol and codeine	Paracetamol, codeine and gabapentin	Solpadol (paracetamol and codeine)
COST	£1000	£9000	£3000

Three transhumeral patients

One BKA patient - **£50,000** over 19 years

TMR

(UK Experience)

Facilities for surgery

- In theory, any plastic surgery or peripheral nerve injury unit
- In practice – **Royal Free only unit in the UK**

Facilities for rehabilitation

- In theory, any Disablement Centre in the UK
- In practice
 - needs specialised bio-feedback equipment
 - trained staff
 - currently only available from Dorset Orthopaedics
 - Approximately £6000 per year per patient

TMR

Royal Free TMR Study

TMR in the prevention of neuroma related pain after below knee amputation

A single-blinded, two-armed, randomized clinical trial of targeted muscle reinnervation (TMR) in the prevention of neuroma related pain after below knee amputation

- 100 patients – mainly vascular
- 50 patients in each group
- TMR versus traction neurectomy (with sham incision)
- Blinded assessment by the psychologists

Thank you



Fox cubs at home - Middlesex