MYOTESTING AND ELECTRODE PLACEMENT FOR SUCCESS IN CLINICAL PATTERN RECOGNITION

This guide describes a proven in-clinic approach to myotesting and electrode contact placement for pattern recognition users. Because pattern recognition utilizes the full information contained in a large number of EMG signals (as opposed to traditional myoelectric control schemes which rely on comparative amplitude information from singular EMG signals), the Coapt pattern recognition system does not utilize industry standard electrode amplifiers; instead, passive electrode contacts are strategically placed throughout the prosthesis-skin interface. The following guidelines describe how this is accomplished.

The clinical guidance highlighted in the following pages follows a 3-step process:

1 DISCUSSION

2 PALPATION

3 POSITIONING ELECTRODE CONTACTS

To begin planning for electrode placement for pattern recognition, have a thorough discussion with the patient about their current perceptions of missing limb movement and muscle contractions. This discussion will encourage the patient to think about control in a new way. It is important to discover what control motions the patient will find intuitive to use.

The **GOALS** of the Discussion are to determine what muscle contractions (motions) the patient feels

1. are intuitive to use for prosthesis control.
2. can be performed consistently.
3. are unique for each intended prosthesis action.

TIPS:

- Lead the discussion.
- Demonstrate motions you would like the patient to attempt.
- Ask questions such as:
  o "Can you feel your hand? Which fingers can you feel you can move?"
  o "Can you imagine making a fist? What about opening your hand with your fingers spread apart?"
  o "Does it feel like your hand is squeezing down on something?"
  o "Do you feel like you can turn your wrist? Does your hand stay relaxed?"
  o "Does your thumb move? How far? Which direction?"
  o … and so on. Remember, the goal is to learn, together, what might be available for control.
- Discuss one movement group at a time; i.e. discuss and practice hand open/close before moving on to wrist motions.
- Encourage the patient to mirror their perceived motions with their sound limb if possible.
- Begin discussing the most intuitive motions and add variations as needed; i.e. try natural hand close for "hand close" and if the patient has poor perception of hand close but good perception of one specific finger (for example), try practicing the use of that finger perception for "hand close." In another example, if wrist rotation is difficult for your patient to perceive, discuss if they can perceive thumb or pinky finger ab/adduction to accentuate rotation.
- Focus on motions that are distinct and repeatable.
- Take your time with this process.
- Be patient and listen to the patient.
- Perform this discussion in a relaxed environment.
- Generate a common vocabulary for motions.
- Incorporate the discussed and practiced motions into a home exercise program for pre-prosthetic control.

The second stage of planning for electrode placement is to repeat the Discussion activities with the patient, but do so while feeling for any underlying muscle activity from their residual limb. Palpation for pattern recognition is <u>NOT an exercise in finding one or two isolated myosites</u>; instead, it is a process to feel for all unique muscle activity including the subtle, the co-contracting, the unexpected, etc. Because of this, feel with as much of your hands as possible and avoid trying to pinpoint activity using your fingertips.

The **GOALS** of Palpation are to

1. feel for all "areas of interest" corresponding to underlying muscle activity related to the control motions.
2. note/remember these "areas of interest" as good locations to place electrode contacts.

TIPS:
- Grasp and cover as much of the patient's limb as possible with your both of your hands.
- Do not only use your fingertips to feel.
- Have the patient perform all of the useful motions discovered during the Discussion phase.
  - Encourage the patient to make medium, comfortable intensity contractions.
  - Have the patient hold each contraction for about 3 seconds and relax between each.
- Feel for the overall general activity – similar to what the pattern recognition algorithm does – by sensing the patterns of activity at multiple areas simultaneously.
- Do not only locate areas of strong, isolated contractions; instead sense all "areas of interest".
- Do not ignore areas of slight/subtle/weak underlying muscle contraction.
- Note any unique and unexpected areas of underlying muscle contraction.
  - For transhumeral amputees this may mean unique muscle activity distal on the residual limb.
- If the patient is tensing all of their muscles quite hard for all of their motions, ask them to make their contractions a little more softly.
- Make temporary markings on patient's residual limb to help remember areas of activity.
- Take your time with this process.
- Be patient and listen to the patient.
- Preform this in a relaxed environment.

POSITIONING ELECTRODE CONTACTS

If the Discussion and Palpation phases have been performed with care, the majority of the information required to locate the electrode contacts will have been acquired. The placement of pattern recognition electrode contacts should capture all of this muscle contraction information.

The **GOALS** of positioning electrode contacts are to

1. cover the "areas of interest" discovered during Palpation.
2. plan accordingly for socket/liner constraints.

TIPS:
- Consider starting with locations corresponding to existing myosites for retro-fits/existing users.
- Identify locations to AVOID placing electrode contacts on, such as
  - areas that will lose electrode-to-skin contact during use.
  - areas outside of socket trim-lines or co-located with valves.
  - areas that have no underlying muscle (i.e. bone only).
  - sensitive skin areas.
  - areas with active EMG during positional loading (e.g. deltoids, brachioradialis).

The COMPLETE CONTROL system utilizes eight EMG signals and each signal requires two passive electrode contacts. These 16 contact points, plus one more for a system-wide reference/ground signal are the 17 contacts that need to be placed. Each pair of electrode contacts that make up one EMG signal pick up an oval-shaped area of muscle signal centered with the two contacts. The closer the two contacts are to each other, the smaller the area of detected EMG.

TIPS:
- SPACING: It is acceptable to position the two electrode contacts for any one EMG channel 30–60 mm apart.
  This is helpful when fitting a larger residual limb – spacing the contacts apart will ensure that all available EMG control information is captured.
- MUSCLE FIBER DIRECTION: It is acceptable to place some of the EMG channels off-axis from the underlying muscle fiber direction.
  This is helpful when fitting a residual limb with unique areas of EMG interest, common for Targeted Muscle Reinnervation patients. This can also be useful for geometrically unique and congenital residual limbs.
- CONTACT SHARING: It is acceptable to have a few of the EMG channels share an electrode contact. Ensure that the two wires for the same EMG channel (common color wires) are NOT sharing a single electrode contact.
  This is helpful when fitting a smaller residual limb – sharing the electrode contacts will limit the amount of electrode hardware required while capturing all available EMG control information.
- SINGLE REFERENCE: The COMPLETE CONTROL system has requires a single electrode contact for purposes of EMG reference/ground. This contact should not be shared with any other EMG signal wires. The reference contact should be positioned in a location that maintains excellent electrode-skin contact.
- GENERAL SYMMETRIC DISTRIBUTION: It is acceptable in some cases to position electrode contacts in a symmetrical arrangement. This is common for transhumeral Targeted Muscle Reinnervation patients and some transradial patients.

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