First World Congress on Innovations in Amputation Surgery and Prosthetic Technologies
May 12-13, 2016, Chicago, Ill. USA

Utilization of Pattern Recognition with Patients Initially Contraindicated for Myoelectric Control in Upper Limb Prostheses

Baschuk, CM, Hoeun, P, Katzenberger, LM, Latour, DA, Passero, T, Tompkins, EJ
Handspring

INTRODUCTION

Weight, comfort, and control complexity have all been indicated in reason for abandonment of a myoelectric prosthesis *(Biddiss, 2007)*.

Traditional myoelectric control has been around since the late 1940's. Although the control circuits have evolved and become more advanced over time, the basic principle of using a minimum EMG threshold voltage to send a control signal to the components of a prosthesis has remained the same.

Even with more advanced control circuits and filtering, it can still be quite challenging for some patients to produce a consistent minimum threshold voltage. A variety of factors can influence this including: skin integrity, sub-cutaneous fat, perspiration, muscle innervation, and fatigue. As a result of this, patients may not be considered candidates for myoelectric control, or they may reject a myoelectric prosthesis over the long term due to frustration with inconsistency of control.

Pattern recognition myoelectric control has been shown to provide equal if not superior prosthetic control as compared to tradition two site myoelectric control *(Simon, 2013).* Pattern recognition functions by comparing the surface EMG of an array of electrodes when the user contracts their muscles to perform a specific motion. This information is then encoded so that the prosthesis moves in the desired manner when the specific muscle contraction is performed.

The recent introduction of a commercially available pattern recognition control system for myoelectric prostheses, the COAPT Complete Control (Coapt LLC, Chicago, IL), provides a new method of controlling externally powered prostheses through myoelectric control. The COAPT system includes a calibration button that the user can access at any time, without a computer, to record up to 5 different calibrations.

Presented here are two case studies in which the patients were not considered candidates for traditional two site myoelectric control due to inconsistent, small surface EMG signals. Both patients were later successfully fit with externally powered prostheses utilizing pattern recognition control through the COAPT Complete Control. These case presentations serve to show that pattern recognition has the potential to expanded the patient population that can benefit from myoelectric control, who only a few years ago would not have been considered a candidate. In addition, it is submitted that the inclusion of a calibration button on the prosthesis empowers the patient and creates greater user satisfaction.

METHODS

This is an observational case study based on patient and prosthetist experience during the prototype, delivery and continued treatment for two separate patients who were initially evaluated for myoelectric control and determined to not be candidates based on poor EMG signal. Patient 1 is a 30-year-old male with a complicated left shoulder disarticulation and brachial plexus injury. Patient 2 is a 60-year-old male who has a short left transradial amputation with a fused elbow joint, significant adherent scar tissue, and large full thickness skin grafts.

As part of each patient's continuum of care they were subsequently retested for myoelectric control and for pattern recognition control once it became commercially available.

During the prototype phase and subsequent to delivery of the definitive prosthesis the patients were followed by a comprehensive team including physicians, occupational therapists, and prosthetists.

RESULTS

Patient 1 was successfully fit with and delivered a fabric socket shoulder disarticulation prosthesis with pattern recognition controlling a powered elbow and multi-articulating hand. Patient 2 was successfully fit with and delivered a custom silicone suction suspension transradial prosthesis with a wrist rotator and multi-articulated hand.

Both patients were able to consistently control their prostheses with increased accuracy over the course of their post-delivery occupational therapy.

Both patients subjectively reported being satisfied with the fit, function, and comfort of their prostheses.

Both patients actively utilize the calibration feature of the COAPT system on a daily basis when they don the prosthesis for optimal control. Both reported that this feature was very important to them.

DISCUSSION

Upon initial evaluation, it was determined that patient 1 would not be a candidate for traditional two site myoelectric control due to a brachial plexus injury that left no EMG signal of the remaining pectoralis muscle. This patient also had sustained a TBI that impaired his cognition making remembering how to activate the different components of his prosthesis through co-contractions or other combinations of signals very difficult.

Patient 1 was later tested for pattern recognition control with the COAPT Complete Control Room. The fitting proved challenging, but ultimately an optimized layout of the 17 electrodes in the COAPT system was determined which allowed the patient to utilize gross motions of the shoulder girdle to control the elbow and terminal device consistently.

Patient 2 was initially determined in 2013 to not be a candidate for myoelectric control due to only trace EMG signals in the forearm. At that point he elected to be fit with a body-powered prosthesis. In late 2015 he was tested again for myoelectric two site control as well as for pattern recognition control. Myotesting for two site control was again unsuccessful, however, he was able to successfully control both hand open/close and wrist pronation/supination independently of the virtual arm in the COAPT software. He was later successfully fit and delivered a transradial myoelectric prosthesis with pattern recognition control in February 2016. Within the first several weeks at home his independence in ADLs had increased significantly.

Both patients expressed that one of the features that they liked best about the pattern recognition system was their ability to recalibrate it on their own when needed. The calibration button empowers the patient to have more control over the function of their prosthesis and can potentially reduce their need to return to the prosthetist for an adjustment if the prosthesis is not functioning as expected.

Because of the intuitive nature of the pattern recognition control system, both patients were able to spend more time in occupational therapy focussing on ADLs rather than on learning the control strategy of their prosthesis.

CONCLUSION

These case studies demonstrate that pattern recognition technology can be utilized in externally powered prostheses for patients who otherwise might have not been candidates for myoelectric control. Anecdotally this suggests that it is important to continually reassess patients as new prosthetic technology is commercially available.

These cases also demonstrate the importance of integrating features into the prostheses that make the patient feel more in control of the device.

REFERENCES

Biddiss, EA et al. *Prosthet Orthot Int*. 31 (3). 236-257. 2007.

Simon, AM et al. *J. Prosthet Orthot*. 25 (2). 30-41. 2013.

***Required Information ***

Presenting Author Information

Name: Chris Baschuk, MPO, CPO, LP
Title/Academic Affiliation: Prosthetist / Orthotist, Handspring
E-mail address: chris@myhandspring.com
Short bio (about 50 words):
Chris Baschuk, MPO, CPO, LP is an Upper Extremity Prosthetics Specialist for Handspring. Chris holds a B.S. in Biomedical Engineering from the University of Utah and a Master of Prosthetics Orthotics from UT Southwestern Medical Center. Chris serves as the Treasurer for the Upper Limb Prosthetics Society of the American Academy of Orthotists & Prosthetists.

Short Description of Your Abstract (2-3 sentences):

Pattern recognition has proved a viable control strategy for myoelectric prostheses. These two case studies demonstrate the potential that pattern recognition control may be utilized in patients who were previously contraindicated for myoelectric control.