INTRODUCTION

Pattern Recognition (PR) has been used in the laboratory for control of advanced prosthetic limbs. However, recent work has shown that it has the potential to improve control of existing clinical prostheses (Huang, et al. 2008). In order to provide consistent and thorough education for users new to the concept of PR control, we have developed a new training protocol. The protocol described will be used to facilitate mastery of PR control before, during and after being fitted with a prosthesis.

METHOD

Understanding the concept of pattern recognition control is the first challenge for individuals with an amputation. With pattern recognition control, it needs to be explained that electrode location no longer corresponds to a specific movement, as in direct control. Consistent patterns of muscle activations are required for each movement. A myoelectric signal viewer can demonstrate these differences in the patterns to the user. It is important to establish common vocabulary for movements and pattern recognition terms, such as ‘calibration’, avoiding too much technical information. Photographs of exercises to be performed with the limb are useful in a home exercise program in preparation for and during training sessions. If possible, training should begin by educating the user on PR by using their sound limb to demonstrate concepts prior to using the amputated limb. This allows them the proprioceptive feedback of the sound limb and they can see how confusion can occur between similar classes (e.g. hand open during wrist extension if the fingers are not kept relaxed). Establish repeatable movements, stressing the importance of performing the movement the same way, and the same intensity level (moderate effort). Begin with educating the user to the process of calibrating the system, by following on-screen cues of when to perform specified movements, and when to relax. Once calibration is complete, begin using virtual reality (VR) avatar to control one degree of freedom (DOF) at a time, adding DOF’s as user demonstrates adequate control. When consistent, independent control of all motions has been achieved, progress to screen testing such as the Motion Test and the Target Achievement Control (TAC) test (Simon, 2011).

Following training with the sound limb, the user can begin training with the residual limb using the same sequence as stated above. Users should be instructed to try to move their phantom limb in the desired direction, even if it feels immobile. Once adequate control is observed, the user can begin training with the prosthesis remotely on a stand to confirm movements without the weight or fit of a prosthesis. When the prosthesis socket is available, it is beneficial to begin training one or two DOF’s using screen-based calibration. Timing of calibration is adjustable to allow adequate time for the user to be prompted and reminded of required movements that were determined in the early training. The user can then practice functional activities when all available DOF’s are being used without excessive effort or postural accommodations. As the user gets more proficient and needs less prompting, they can progress to the quicker prosthesis guided training, where the user will be required to perform the movements along with the prosthesis following a predetermined order (Lock, 2011). This will also allow the user to recalibrate the prosthesis whenever control seems degraded, a new DOF is added, or they are performing activities in extreme arm position, such as overhead reach. Therapy with the prosthesis continues to work on functional activities as well as re-addressing pattern recognition concepts throughout training sessions.

RESULTS

Thus far, we have utilized the pattern recognition training guide with one TMR transhumeral user. Improved understanding of the pattern recognition concepts was reported. This decreased confusion between classifiers, both in a VR environment as well as bench-top control of prosthesis.

DISCUSSION

Further refinement will continue to be indicated with the pattern recognition control guide as new subjects are recruited and trained to ensure continued success.

CONCLUSION

Our experience with pattern recognition in the lab and community is continuing to evolve. This training protocol will be utilized with our TMR subjects as well as our non-TMR subjects.

CLINICAL APPLICATIONS

Consistent presentation of the pattern recognition concepts to new users by all clinicians can improve prosthetic functional performance and move PR towards clinical implementation.

REFERENCES