A COMPARISON OF DIRECT AND PATTERN RECOGNITION CONTROL IN TRANSHUMERAL TMR SUBJECTS

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INTRODUCTION

Following the Targeted Muscle Reinnervation (TMR) procedure, an individual with a transhumeral amputation is able to control elbow and hand functions of a myoelectric prosthetic arm simultaneously. However, obtaining isolated electromyographic (EMG) signals for each of these functions can be difficult using traditional control methods (direct control). Pattern recognition algorithms decode EMG signals produced when a muscle contracts, and can be trained to recognize and distinguish a person's distinct muscle patterns (Kuiken, 2009).

The purpose of this study was to compare an individual's ability to control a commercial arm system using ether direct or pattern recognition control in a home trial.

METHOD

Subjects: Eight subjects with transhumeral amputation who had previously undergone TMR were recruited for the study. All subjects were male and had a medium to long residual limb.

Apparatus: Outcomes included the Box and Blocks test, the Jebsen Hand Function test, the Southampton Hand Assessment Procedure (SHAP), and the Clothespin Relocation Task. A custom survey was also administered.

Procedures: Subjects were fit in random order with direct or pattern recognition control of a Boston Digital Arm system, a Motion Control wrist rotator, and a terminal device. Subjects could choose between an Otto Bock Hand or Greifer, or a Motion Control ETD. During the direct control phase, subjects used their intact biceps and triceps to control the elbow and two TMR sites to control the hand/wrist. Subjects used each control method at home for a minimum of 6 weeks. Outcomes were administered pre- and post-home trial.

Data Analysis: An analysis of variance was performed using a general linear model with each subject as a random factor, control type, and pre/post testing as fixed factors for each outcome measure.

RESULTS

No statistical differences were noted in the results of the Jebsen or the Box and Blocks test. However, there was a significant difference in SHAP scores, with the pattern recognition control system performing statistically better (p=0.024) (Fig. 1). Also, during the Clothespin Relocation Task, subjects were able to move the three pins from the horizontal bar to the vertical bar faster with pattern recognition compared to direct control (p=0.009) (Fig.2).

DISCUSSION

Seven out of eight subjects preferred pattern recognition over the direct control configuration. The subject who preferred direct control stated that it was simpler and he frequently had confusion between the hand and the wrist movements when using pattern recognition control. The other subjects all noted that with pattern recognition, they no longer had to switch between the hand and wrist. Future work will investigate the ability of subjects with TMR who use pattern recognition to control additional degrees of freedom, including a wrist flexor and multi-articulating hand.

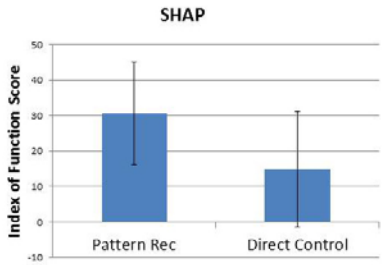

Fig 1. Comparison of SHAP test results between direct and pattern recognition control.

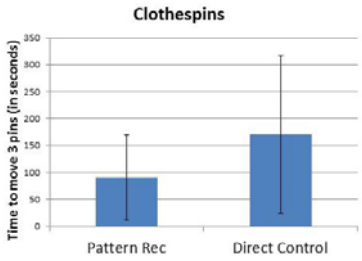

Fig 2. Direct versus pattern recognition control during the Clothespin Relocation Task.

CONCLUSION

When using pattern recognition control, subjects with transhumeral amputation who received TMR could operate their myoelectric prosthesis better when compared to using direct control.

CLINICAL APPLICATIONS

Based on the improved functional testing and subject preference, pattern recognition is a viable clinical option for transhumeral TMR patients. Future studies should include subjects with other levels of amputation.

REFERENCES

Kuiken, TA et al. JAMA 301(6): 619-28, 2009.

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