

HOME USE OF A SENSORY RESTORATION SYSTEM: SENSATION STABILITY AND IMPACT ON USAGE

¹Emily Graczyk, ²Linda Resnik, ³Melissa Schmitt and ¹Dustin Tyler

¹*Case Western Reserve University*

²*Providence VA Medical Center*

³*Cleveland VA Medical Center*

INTRODUCTION

While neural prostheses to restore sensory feedback to upper limb amputees have the potential to improve task performance and quality of life, studies of sensory restoration systems (SRSs) have only been conducted in controlled laboratory environments. In this study, for the first time, two subjects used a SRS autonomously in a home setting. We report on the technical implementation of the SRS, sensation stability, and participants' attitudes towards and usage of the sensory-enabled prosthesis.

METHODS

Two persons with unilateral trans-radial amputation participated. S1 was implanted with 8-channel Flat Interface Nerve Electrodes (FINEs) around his median and ulnar nerves in May 2012, and S2 was implanted with FINEs around his median and radial nerves in January 2013. The SRS consisted of an Ottobock VariPlus Speed prosthetic hand customized with an embedded aperture sensor and fingertip pressure sensors on D1-D3, an external nerve stimulator with a custom sensory stimulation program, and cabling to connect the stimulator to percutaneous leads. The stimulator mapped pressure signals from the finger sensors into stimulation pulse trains and delivered the stimulation to four electrode contacts on the median nerve.

The five-week ABA crossover study involved two 14-day stages without sensory stimulation (A) surrounding one 7-day stage with sensory stimulation (B). Each day subjects completed surveys on sensory stimulation percepts and reported on their performance of items from a list of everyday activities. On-board usage logs monitored wear time and sensor readings. Interviews were conducted to capture subject perspectives on the SRS. Data was compared across stages to evaluate the effect of sensory feedback.

RESULTS

Subjects were able to independently don and doff the SRS, change stimulation settings, and calibrate the prosthetic sensors. Stimulation parameters and sensation locations

remained stable throughout the duration of the study. In stage B, with sensory stimulation, subjects wore the SRS longer (sensation on: 8.4 +/- 3.8 hrs (S1), 8.3 +/- 2.2 hrs (S2); sensation off: 4.7 +/- 2.6 hrs (S1), 6.3 +/- 2.0 hrs (S2)), used it more frequently to touch/manipulate objects (S2: $p=0.03$), and reported using their prosthesis to do more activities (S1: $p=0.03$; S2: $p<0.001$). Participants preferred using the prosthesis with sensation enabled.

CONCLUSIONS

Two trials of a take home SRS were successfully completed and demonstrate initial feasibility. The SRS was well-received. Interviews and usage logs indicated that subjects preferred using the prosthesis with sensory feedback. Robustness, reliability, and ease of use are critical design features for an SRS.