Afferent Peripheral Nerve Stimulation for Motor Rehabilitation Controlled by Movement Intention in an EEG-based Brain-Machine Interface

Sarah Thomas [1] • *Christopher Schildt, MS* [1] • *Elizabeth Powell, MS* [2] • *Matthew Ballard* [1] • *Sara Salles* [2] • *Lumy Sawaki, MD, PhD* [2] • *Sridhar Sunderam, PhD* [1]

[1]Biomedical Engineering, University of Kentucky • [2]Physical Medicine and Rehabilitation, University of Kentucky

Individuals with upper cervical injury to the spinal cord lose the use of their lower limbs but sometimes retain sensory and motor function in the upper limbs, albeit with severe impairment. Improvement of hand function would add greatly to their quality of life. Afferent peripheral nerve stimulation (PNS) has been previously shown to increase motor rehabilitation efficiency in a motor impaired population with PNS timing playing an important role according to paired associative stimulation trials. This study utilizes a novel electroencephalograph (EEG)-based brain-machine interface (BMI) system for controlled PNS application during motor therapy. With IRB approval, twelve participants (47.3 ± 3.1 years of age) with stable (123.1 ± 38.7 months since injury) cervical spinal cord injuries (C3-C6) were enrolled in an afferent PNS coupled hand grip motor rehabilitation intervention over 4-6 weeks with one subject dropping out after seven sessions. Mean PNS latency relative to movement onset was used to establish groups for comparison. When compared to participants with PNS applied after movement onset on average (n=4), participants with PNS applied prior to movement onset on average (n=9) demonstrated an increased maximum voluntary hand grip contraction (MVC) force change (left hand: 80±20% ($p<0.01$); right hand: 103±47% ($p<0.05$)) and an increase in TMS elicited motor evoked potential (MEP) cortical map volume (3.8±1.4 ($p<0.05$) for the left brain). These early findings not only demonstrate the feasibility of close temporal control of PNS for a motor impaired cohort using a novel BMI system, but also suggest an increased rehabilitative response when PNS timing is synchronized with movement intent.