Project Abstract

Though stroke is the leading cause of disability worldwide, even the most effective gait rehabilitation treatments have only about a 50% response rate in improving walking function. This low rate highlights a critical gap since impaired walking ability significantly decreases quality of life and increases risk of loss of independence and serious secondary health conditions. To improve rehabilitation outcomes, treatment design should be backed by research evidence and account for the neuromechanical and physiological mechanisms prevalent in individuals post-stroke. The purpose of this project is to evaluate whether patient-specific neuromusculoskeletal walking models can be used to design fast functional electrical stimulation (FastFES) interventions that improve rehabilitative outcomes for post-stroke walking impairments. Our premise is that *objective models* based on physics and physiology will be able to identify more effective and individualized electrical stimulation designs (which muscles to stimulate, when to stimulate them, and how much to stimulate them) than can traditional *subjective methods* based on clinical intuition and a one-size-fits-all approach to FES. Patient-specific neuromusculoskeletal walking models will be constructed in OpenSim/Matlab for two subjects with post-stroke hemiparesis who are already participating in a FastFES research study being conducted by collaborators at Emory/Georgia Tech. One subject will be a responder and the other a non-responder to a standardized FastFES protocol that stimulates paretic ankle plantarflexor and dorsiflexor muscles during late stance and swing, respectively. Skeletal, muscle, and neural control properties of each patient-specific model will be calibrated using the subject's motion, ground reaction, and EMG data collected during unstimulated walking on an instrumented treadmill. Model calibration and subsequent prediction of optimal stimulation design will be performed using EMG-driven modeling and direct collocation optimal control methods recently developed in the PI's lab. We will explore whether the patient-specific models are able to 1) ***distinguish*** the responder from the non-responder based on model-predicted changes in walking mechanics produced by simulated standardized FastFES, and 2) ***identify*** unique, patient-specific FastFES prescriptions that, at least theoretically, would produce larger improvements in walking ability than those achieved by standardized FastFES prescriptions. The results from this pilot project will provide the preliminary data needed to support a subsequent NIH R01 grant application with our Emory/Georgia Tech collaborators.