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Modeling Neuromusculoskeletal Alterations after Spinal Cord Injury

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The interaction between neural and musculoskeletal systems enables us to perform a variety of motor tasks in a robust and adaptable manner. Damage to one system component, e.g. traumatic spinal cord injury (SCI), can lead to long-term secondary changes in other interacting system components. These secondary changes may be maladaptive and further reduce functional capacity or they may be favorable and result in recovery of function. We will discuss the current status the CRCNS project in which we will utilize a link between experimental studies in uninjured and incomplete SCI rodents with detailed mathematical model of the biomechanics and neural control of the rodent hindlimb for investigating motor control.

Specifically, the experiments are for investigating the intrinsic intracellular electrophysiology of spinal motoneurons and their afferent control and the intrinsic musculoskeletal properties present after incomplete SCI. The data will guide development of a computational model with Hodgkin-Huxley type neuron representations for the local spinal neural circuits and afferents involved in specific spinal reflexes and dynamic musculoskeletal components. The musculoskeletal model will incorporate experimentally-determined geometrical musculotendon paths, inertial properties, muscle fiber properties, and 3D laser scanned bony surface geometries. The comprehensive model will consequently be used to test hypotheses regarding the roles of specific ionic currents, altered central drive, altered musculoskeletal properties and altered sensory reflex gain on control of limb movement after incomplete SCI. Successful completion of the work will provide novel information that could help guide the development of efficient treatment techniques and appropriate rehabilitative therapies for enhancing functional locomotor recovery for people currently living with SCI related limitations.

Project (or PI) Website

http://www.biodesign.asu.edu/centers/ans

Publications

1. Graham, J., V. Booth and R. Jung. Modeling motoneurons after spinal cord injury: Persistent inward currents and plateau potentials.
Neurocomputing 65-66, 719-726, 2005.

2. Thota, A., S. Carlson-Watson, E.J. Knapp, B.T. Thompson, and R. Jung. Neuromechanical control of locomotion in the rat. Journal of Neurotrauma. 22(4): 442-465, 2005.