Activity-Based Therapies in Spinal Cord Injury: Clinical Practice and Ongoing Research

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Research Abstract

Studies in animals and humans have shown that the functionally isolated human spinal cord maintains specific properties recognized to generate locomotion in other species. These concepts now have been translated into the clinic by the Christopher and Dana Reeve NeuroRecovery Network of seven rehabilitation centers that provide standardized Locomotor Training to individuals with chronic incomplete spinal cord injury. Two hundred and six individuals ranging from 0.9 to 26 years post injury were assessed during intensive Locomotor Training, including step training using body weight support and manual facilitation on a treadmill followed by overground assessment and community integration. Significant improvement from enrollment to final evaluation was observed in balance and walking measures for AIS C and AIS D patients. These results indicate that rehabilitation that provides intensive activity-based therapy can result in functional improvements in individuals with chronic incomplete SCI even years after injury.

In another study we hypothesized the human spinal locomotor circuitry has sufficient automaticity potential to generate postural control and rhythmic, coordinated weight bearing stepping and that we can recruit this locomotor and postural circuitry with a tonic epidural stimulation of selected lumbosacral segments. We implanted in three individuals with motor complete SCI. We implanted a 5-6-5 electrode array epidurally spanning L2-S1 spinal cord segments and a neurostimulator (Medtronic) capable of stimulating any combination of the 16 electrodes in the array at intensities up to 1 and with frequencies ranging from 2-50 Hz. While sitting, without epidural stimulation, we observed minimal EMG activity in leg muscles. While standing in a supportive system without stimulation and with assistance provided at both knee joints trainer, little or no observable EMG activity occurred in the leg muscles. With epidural stimulation the transition from sitting to standing was accompanied by an increase in the EMG amplitude by orders of magnitude beyond that observed in the sit position. In addition, after several months of training he was able to voluntarily move his legs in the presence of epidural stimulation. These results demonstrate the interaction between sensory and epidural regulation of locomotor circuitry. These results also show that a physiological state can be achieved with epidural stimulation so that the sensory input can effect control the locomotor circuitry to stand.

Supported by National Institute of Health, Christopher and Dana Reeve Foundation, Helmsley Foundation, Kessler Foundation, Frist Institute, University of Louisville Foundation, Kentucky Spinal Cord and Head Injury Research Trust and Kentucky Spinal Cord Injury Center.

Basic concepts of activity-based interventions for improved recovery of motor function after spinal cord injury.

Establishing the NeuroRecovery Network: multisite rehabilitation centers that provide activity-based therapies and assessments for neurologic disorders.

Balance and ambulation improvements in individuals with chronic incomplete spinal cord injury using locomotor training-based rehabilitation.