Enhancing locomotor function in incomplete spinal cord injured humans with non-invasive direct current stimulation

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Modulating the excitability of the spinal cord by continuous electrical stimulation and/or administration of drugs can enable stepping in rodents with a complete spinal cord injury (SCI). Recently, it has been shown that epidural spinal cord stimulation (ESCS) in combination with the admittance of serotonergic agonists induces full weight bearing stepping in rats with a complete spinal cord transection. Also in humans continuous ESCS of lumbar posterior roots could modulate the activity of spinal neuronal networks and induce locomotor-like movements. In a single case study it has been shown that the combination of ESCS and locomotor training facilitated the recovery of functional walking in an incomplete SCI subject. However, ESCS is an invasive method with corresponding risk. In contrast transcranial direct current stimulation is a well-established non-invasive method to modulate brain excitability. Although this method has been intensively studied on the influence on the brain only limited information is available on the possible effects that direct current (DC) stimulation has on spinal neuronal circuitries. It would be of high interest for clinical interventions if a non-invasive approach could modulate spinal networks and possibly have a beneficial effect on the recovery of functional walking in subjects with incomplete SCI.

The goal of this project is to investigate whether DC stimulation can modulate spinal neuronal circuitries and locomotor output of the spinal cord. To address this question the influence of DC stimulation on the polysynaptic spinal reflex, which is assumed to be involved in locomotor generating networks, will be studied in healthy and complete SCI subjects. Moreover we will examine if DC stimulation facilitates locomotor activity. Therefore the influence of DC stimulation on gait kinematics and electromyographic (EMG) muscle activity will be analysed during treadmill and over ground walking in incomplete SCI subjects. Detailed kinematics will be assessed using a motion capture system (VICON) with 8 infrared television cameras and two digital video cameras (Basler Vision Technologies) and muscle activity will be recorded using a direct transmission system (Noraxon) for wireless EMG recordings.

This study has the potential to significantly influence the design of future rehabilitation interventions to enhance recovery after incomplete SCI.