Non-invasive electrical stimulation of the cervical spinal cord to facilitate arm and hand functional recovery in incomplete traumatic cervical spinal cord injured patients, (CERMOD)

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Injury to the spinal cord is irreparable. There are no current treatments that promote the reconnection between the brain and the spinal cord neurons below the injury. Over the last years several strategies have focused on promoting the regeneration of the damaged spinal axons across the injury. Although several treatments have shown promising results in experimental animal models, none of them are yet available for treating human patients. A novel approach, which has opened great expectations, is the development of bioengineering technologies. The development of bio-electronic devices is intended to modulate the preserved connections between the brain and the spinal cord or to further restitute the damaged nervous tissue in more severe neurological conditions. Along this line, experiments in which electrical current has been delivered to the spinal cord through implantable electrodes have facilitated hind limb function in both animal models and human patients. However, it is unknown whether or not the same technology can be applied to the cervical spinal cord to facilitate recovery of arm and hand function. In the present proposal, we have designed a set of experiments both in animal models and in human patients to obtain a proof of principle of the utility of non-invasive transcutaneous electrical stimulation to facilitate arm and hand recovery. To achieve this objective, we have built an international consortium of leading laboratories, which employ a complementary set of penetrating experimental techniques and animal models. To achieve its objectives, the proposal is divided into 4 work packages (WP), which will be individually developed in each of the consortium laboratories. In WP1 we will identify the best stimulation parameters to facilitate reaching and grasping recovery in cervical contused rats and identify the cervical spinal neurons involved in this motor task. In WP2, we will study in transgenic mice the relationship between the plasticity of the spinal inhibitory system and the recovery generated by the electrical stimulation. In WP3, we will evaluate and optimize in non-human primates the acute and long term facilitation (or inhibition) of spinal cord function generated by electrical stimulation, and finally in WP4, we will Implement a technology recently developed in the US to deliver painless non-invasive transcutaneous stimulation of the spinal cord, beginning with stimulation parameters that have been shown to activate lumbar spinal networks in humans. We will then optimize the stimulation parameters using as a reference the results obtained in the animal model studies.