PROJECT

Supervisor**:** **Dr. Michele Bailo, MD, PhD**

Title: **Central Nervous System MRI Changes Related to Spinal Cord Stimulation for motor restoration After Non-traumatic Spinal Cord Injury**

Curriculum: **Clinical and Experimental Medicine**

Link to the personal page of the University or relevant hospital site website:

https://research.hsr.it/en/divisions/neuroscience/oncological-and-regenerative-neurosurgery/michele-bailo.html

https://www.hsr.it/dottori/michele-bailo

Description of the Project (max 3,000 characters including spaces)

Background / gap of knowledge

Non-traumatic spinal cord injury (NTSCI) is a severe condition that can result in the loss of essential neurological functions, including motor and sensory deficits up to complete paralysis (1). In recent years, spinal cord stimulation (SCS) has gained increasing application in patients with traumatic spinal cord injury. When combined with rehabilitative training, SCS has been shown to promote recovery of lower-limb motor function, leading to functional improvements in selected individuals (2,3).

Rationale and hypothesis

The mechanisms underlying stimulation-enabled motor recovery and the sources of inter-individual variability remain poorly understood. We hypothesize that SCS combined with task-specific rehabilitation may induce measurable and sustained neuroplastic reorganization across spinal and supraspinal networks. Multimodal central nervous system (CNS) magnetic resonance imaging (MRI) may be used to assess reorganization of brain and spinal motor networks (4,5).

Previous studies have already demonstrated that SCS implanted for the treatment of chronic neuropathic pain is associated with modulation of cortical connectivity. Significant changes in brain plasticity have been reported after SCS implantation, particularly in regions involved in pain perception and processing (6,7). By analyzing neuroimaging data and integrating them

with clinical measures, this project aims to investigate whether SCS-assisted rehabilitation influences brain neuroplasticity and to determine whether these neuroplastic changes can serve as potential biomarkers for predicting individual responsiveness to the treatment.

Objectives and specific aims

1) To investigate brain and spinal neuroplasticity and network reorganization associated with SCS-assisted rehabilitation, in order to understand whether treatment-related changes in neural circuits are linked to motor improvement.

2) To develop an artificial intelligence model integrating clinical data, multiparametric brain and spinal MRI to identify imaging biomarkers predictive of individual response.

Expected outcomes

The project is expected to identify brain and spinal neuroplastic changes associated with SCS-assisted rehabilitation and their relationship with motor recovery, addressing a current gap in the scientific literature.

Skills that the student should acquire (max. 600 characters including spaces):

During the project, the student will acquire the following skills:

-Understanding SCS protocols aimed at improving motor function;

-Interpretation and analysis of MRI data in patients with NTSCI;

-Evaluation of longitudinal CNS MRI changes and their relationship with clinical outcomes;

-Development of machine learning models to identify imaging biomarkers predictive of treatment responsiveness;

-Preparation and drafting of scientific reports and research articles.

References (max. 15)

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