Using Vicon to evaluate the change in the motor function during electro stimulation in rats

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The main objectives of our study were the motor symptoms of Parkinson's disease. Neuro stimulation is an electrical effect on brain structures through percutaneous or implanted electrodes. In research we used video analysis of motion (Vicon system) to evaluate the change in the motor function and understand the effectiveness of the electro stimulation. In the video analysis of motion using specialized infrared cameras, the position and movement of the object in space is monitored. After that, we get data of the position of each of the markers, which can potentially be used to analyze the disturbance of the motor function and its subsequent recovery. In the work, video analysis was used to analyze the movement of rats, Parkinson's patients before and after electro stimulation. Electro stimulation is one of the most effective ways to combat the symptoms of Parkinson's disease. In the study video data of the motion was analyzed to understand the influence of electro stimulation on quality of the motion function. It was shown that the variation in angular values in the joints of the pelvic limb of a rat during walking, high values of the standard deviation may indicate the presence of muscle tremor. The results also show that electrical stimulation of the spinal cord has a positive effect on restoration of locomotion after neuronal damage caused by the model of Parkinson's disease in rats. It can be concluded that electrical stimulation of the spinal cord has a positive effect on the biomechanical characteristics of locomotion in Parkinson's disease. Biography Mikhail Zaytsev is currently pursuing Bachelor’s degree program in the Kazan Federal University, Institute of Fundamental Medicine and Biology.

Introduction-

Damage to the central nervous system (CNS), due to either acute events such as cerebral ischemia or spinal cord injury (SCI), or prolonged neurodegenerative diseases such as Parkinson Disease (PD) or Multiple Sclerosis (MS), can result in lifelong impairment of sensorimotor functions (e.g., reaching, grasping, standing, and/or walking). Once damage, the CNS undergoes a cascade of complex changes both within the brain and across spinal cord sensorimotor networks that integrate sensory signaling and motor control commands to produce coordinated neuromuscular activity.

The anatomical overlap of sensory signals that originate in the peripheral nervous system and converge upon spinal sensorimotor networks via multi-segmental innervations to the spinal cord and the brain suggests that, multiple CPGs across central nervous system could integrate sensory signaling to allow real-time optimization of motor outputs in response to external perturbations17,18,19,20 (Fig. 1a). It is expected that CPGs at different level of CNS are able to coordinate activity during complex motor functions, such as standing, stepping, or running. However, the distinct role of the neuronal circuitry of CPG during motor task performance, as well as the mechanism by which multiple CPGs coordinate their activity remains undefined.

Methods-

Multifactorial behavioral assessment (MfBA) system

The multi-factorial assessment system consists of the following main components: (1) BWS apparatus integrated with force and torque transducers, (2) motion tracking system, (3) open field camera, (4) interface with chronically implanted electrophysiological recording electrodes, (5) interface with chronically implanted neural stimulation electrodes, (6) motorized treadmill, and (7) open field platform. Through hardware level communication between these modules the system combines behavior, locomotion and electrophysiology in either an open field or treadmill environment with the flexibility to position animals for bipedal or quadrupedal stepping.

Based on our previously published findings on modulation of spinal cord motor evoked potentials during standing41 and stepping42, we introduced evaluation of motor evoked potentials during task-related modulation of spinal circuitry (functional Motor Evoked Potentials or fMEP) in SCI rats 4 weeks after injury (Fig. 5a). Body weight supported multimodal system was designed for this study to provide a wide range of modulation of inputs and outputs to the spinal circuitry. Performed based on the number and amplitude of the selected components, fMEP analysis provides important information about modulation of the different components of spinal circuitry related to stepping.

Discussion-

Traditionally, rodent locomotor activity after SCI has been assessed using the Basso-Beattie-Bresnahan (BBB) open field locomotor rating scale, which summarizes the extent of motor recovery and has been correlated to lesion severity43,44. At the same time, the BBB and similar measures only44,45,46 account for a few basic movement characteristics while lacking sensitivity to locomotor variability and electrophysiological outcomes47. In response to these limitations, more sensitive methods to measure motor recovery, using kinematics, kinetics, and EMG48,49 were employed.

In summary, by combining multiple assessment parameters including kinematic, kinetic, open field, and electrophysiology during therapeutically-enabled locomotion, we have established and tested a comprehensive real-time evaluation of motor behavior in healthy rodents and in rodents with neurologic deficits at the different CNS levels that significantly impact motor activity. Additionally, we provide evidence that MfBA combined with fMEP analysis is effective tool for at dissecting therapeutically-enabled gait characteristics and at targeting of different components of locomotor circuitry related with variations in motor behavior. Novel MfBA approach and designed for this purpose BWS system provide a platform for future investigations of the interactions between CNS inputs and outputs while manipulating external perturbations, and therapeutic administration in order to better understand how the CNS coordinates and executes complex.

References-

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