【Grant-in-Aid for Scientific Research (S)】

Broad Section I

Title of Project : Neural Mechanisms of Functional Recovery via Artificial Neural Connection

Yukio Nishimura
(Tokyo Metropolitan Institute of Medical Science, Department of Dementia and Higher Brain Function, Neural Prosthesis Project, Project Leader)

Research Project Number : 18H05287 Researcher Number : 20390693
Keyword : Artificial Neural Connection, Spinal cord Injury, Functional Recovery

【Purpose and Background of the Research】

Motor impairment in individuals with spinal cord lesion is attributed to the interruption of descending pathways to the spinal circuit, whereas neural circuits below and above the lesion maintain their functional capability. An artificial neural connection (ANC), which bridges supraspinal centers and spinal networks beyond the lesion, may restore the functional impairment. We have shown that ANC enable to compensate for the dysfunction of descending pathways by sending commands to the preserved spinal circuits and enable individuals with paraplegia to regain volitionally controlled paralyzed limb. Individuals may be required to learn a novel causal input-output relationship to control the paralyzed limb. Although, how the brain incorporates a novel "artificial" neural pathway into volitional limb control within the surviving cortical areas remains largely unclear. Using animal model of spinal cord injury (SCI) and SCI patients, the aim of study is elucidate neural mechanisms of adaptation and plasticity in central nervous systems induced by ANC (Fig. 1).

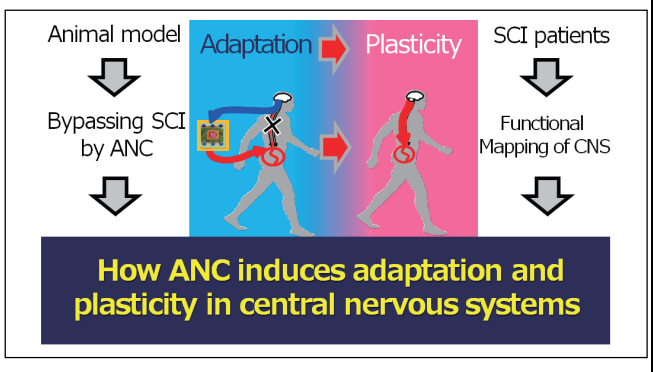

Fig. 1 Research aim

【Research Methods】

We implants multi-channel electrode array in cortical motor area and spinal cord in monkeys. To regain volitional control of the paralyzed hand, the monkeys SCI models are connected to the ANC which bridge cortical motor area and preserved spinal circuits. We investigates neural firing of population cortical cells throughout adaptation process to ANC.

We apply non-invasive ANC in paraplegic humans with chronic SCI to induce functional recovery of voluntary limb control. We investigates cortical and spinal reorganization by MRI and electrophysiological methods.

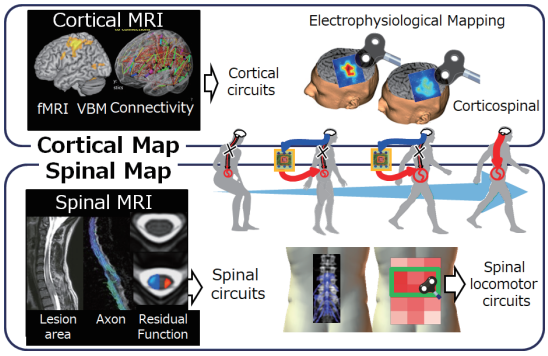

Fig. 2 Functional Mapping

【Expected Research Achievements and Scientific Significance】

The results will show neural mechanisms of functional recovery induced by ANC and propose an innovative neruorehabiliation for SCI

【Publications Relevant to the Project】

・Nishimura Y, Perlmutter SI, Eaton RW, Fetz EE. Spike-timing-dependent plasticity in primate corticospinal connections induced during free behavior. Neuron. 2013;80(5):1301-9.
・Sasada S, Kato K, Kadowaki S, Groiss SJ, Ugawa Y, Komiyama T, Nishimura Y. Volitional walking via upper limb muscle-controlled stimulation of the lumbar locomotor center in man. J Neurosci. 2014 Aug 13;34(33):11131-42.

【Term of Project】 FY2018-2022

【Budget Allocation】 113,200 Thousand Yen

【Homepage Address and Other Contact Information】

http://www.igakuken.or.jp/project/detail/neuroprosth.html