The Chinese University of Hong Kong

Department of Biomedical Engineering

Graduate Seminar – PhD Oral Defence

Student	:	Mr. BAO Shichun
Supervisor	:	Prof. Raymond TONG
Date	:	20 June 2019 (Thursday)
Time	:	9:00 a.m.
Venue	:	Room 215, William M W Mong Engineering Building (ERB)

Title: Modulation of Cortico-muscular Coupling Following Electrical Stimulation in Chronic Stroke Subjects

Stroke is one of the leading causes of death and disability worldwide. Its survivors experience peripheral impairment contralateral to their stroke onset hemisphere, and more than half of them never achieved full motor recovery. Electrical stimulation might promote motor recovery by stimulating the brain or peripheral nerves. Transcranial direct current stimulation (tDCS) on the scalp could increase motor cortex excitability, while neuromuscular electrical stimulation (NMES) applied on the peripheral muscles could elicit sensory input and modulate the contralateral sensorimotor cortex. However, the modulatory mechanisms of electrical stimulation on stroke subjects are still not well understood. Cortico-muscular coupling is a neurophysiological indicator of functional coupling between brain and muscles, and might serve as a measure of cortical functional related contribution to motor recovery. This study explored cortico-muscular coupling following electrical stimulation using tDCS and NMES.

Firstly, this work investigated whether high-definition (HD) tDCS could induce modulatory effects on the ipsilesional primary motor cortex in chronic stroke subjects. HD-tDCS has better stimulation focality and targeting ability, and can change motor excitability that significantly exceeds both the magnitude and duration of conventional tDCS. Each subject received three types of HD-tDCS (anode, cathode and sham) with at least one-week washout period. Wrist isometric contraction tasks were conducted for the affected upper limbs before and 10, 30, and 50 minutes after 10-minute 1mA HD-tDCS. The cortico-muscular coherence (CMC) was compared across task sessions and stimulation conditions. The largest neuromodulation effect was observed at around 10 min immediately after anode HD-tDCS. Moreover, this work explored the bidirectional closed-loop motor control process and the direction of information flow following HD-tDCS, renormalized partial directed coherence (RPDC) based on multivariate autoregressive (MVAR) modeling was acquired. Anode HD-tDCS might only promote the descending pathways of cortico-muscular coupling, which demonstrates the functional role of the primary motor cortex to control the external muscles.

Moreover, the modulatory effects of NMES in neuro-motor control process during rhythmic pedaling was scrutinized. Both healthy and chronic stroke subjects participated in this study and underwent a ten-minute passive, active or NMES pedaling experiments. The neuromuscular contribution during different pedaling protocols was explored. The cortico-muscular coupling between identified cortical source clusters and lower limb muscles was calculated with generalized partial directed coherence (GPDC), GPDC of NMES pedaling tends towards active pedaling. NMES could modulate the GPDC of both ascending and descending pathways for healthy subjects, but it could only induce significant modulation effects in ascending pathways for stroke subjects.

***** ALL ARE WELCOME *****

For enquiries, please contact Ms Joyce Chan, Department of Biomedical Engineering at 3943 8278