EEG correlates of changes in motor-cortex excitability related to ipsilateral movement

Dubravko Kičić[1,2], Vadim V. Nikulin[3], Pantelis Lioumis[1,2], Risto Ilmoniemi[4,2]

1 – BioMag Laboratory, Engineering Centre, Helsinki University Central Hospital, Helsinki, Finland
2 – Helsinki Brain Research Center, Helsinki, Finland
3 – Karolinska Institutet, Department of Clinical Neuroscience Clinical Neurophysiology, Karolinska University Hospital
4 – Nexstim Ltd., Helsinki, Finland

Various cortical areas are involved in the preparation and execution of unilateral movement. Numerous studies indicate that not only bilateral but also unilateral movements are associated with activation of both hemispheres. Even when performing a unilateral movement one can observe electromyogram (EMG) in both hands although the required movement is performed by one hand only (Kristeva et al. 1991). In the same study, the results of magnetoencephalographic measurements indicate that there is change in magnetic field configuration over motor areas already about 500 ms prior to EMG onset and this activation is bilateral. This result indicates that both motor cortices (M1) become active at the same time. Recently, in combined TMS and EEG study Rau et al. (2003) showed enhanced corticospinal excitability in the ipsilateral motor cortex during self-paced finger movements supporting the concept of an active contribution of ipsilateral M1 in the control of movement execution in the active (ipsilateral) limb.

In our study the goal was to further understand the physiological role of ipsilateral motor cortex in motor control by detection of changes in cortical excitability during the preparation and execution of a movement. We set up the experiments where the subject had to perform a quick abduction of thumb as the response to the visual cue (visual checkerboard on the screen). TMS was applied to ipsilateral M1 in two runs and to contralateral M1 in two runs. In two runs, the subject did not have to perform the movement. Simultaneous EEG was recorded using 60 channels covering the whole head.

Our preliminary results show that when subject performs a movement the cortical excitability in ipsilateral M1 is changed, but to a lesser extent than in the contralateral M1. This change is registered as an attenuation of the amplitude of TMS-evoked N100 EEG response. This result indicates that the cortical excitability during the preparation and execution of unilateral movement is changed not only in the contralateral but in the ipsilateral hemisphere as well. Moreover, modulation of ipsilateral N100 by visual stimulus only in no-movement condition (Nikulin et al. 2003) indicates that visual information has an access to a bilateral motor network, which might be a basis for a quick motor responses required by unexpected stimuli.

References:

1. Kristeva R, Cheyne D, Deecke L. *Neuromagnetic fields accompanying unilateral and bilateral voluntary movements: topography and analysis of cortical sources.* Electroencephalogr Clin Neurophysiol. 1991 Aug;81(4):284-98.

2. Nikulin VV, Kičić D, Kahkonen S, Ilmoniemi RJ. *Modulation of electroencephalographic responses to transcranial magnetic stimulation: evidence for changes in cortical excitability related to movement.* Eur J Neurosci. 2003 Sep;18(5):1206-12.

3. Rau C, Plewnia C, Hummel F, Gerloff C. *Event-related desynchronization and excitability of the ipsilateral motor cortex during simple self-paced finger movements.* Clin Neurophysiol. 2003 Oct;114(10):1819-26.