

Analysis of Subcortical Beta Activities in Stroke Patients for Motor Rehabilitation

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Introduction: Motor disabilities are one of the main symptoms in stroke patients. For the stroke patients, it is important to understand differences in motor function-related subcortical activities compared to healthy subjects. However, subcortical activities in chronic stroke patients are still unknown during motor execution. In this study, we investigated the different subcortical activities between the stroke patients and the healthy controls using a source localization from electroencephalogram (EEG) signals.

Material, Methods and Results: Eleven chronic stroke patients with subcortical lesion (54.3 ± 8.2 years) and twelve healthy controls (54.8 ± 2.2 years) participated in the finger tapping experiment using affected hand or dominant hand, respectively. Eight patients suffered from infarction and three patients suffered from hemorrhage. Mean Fugl-Mayer Assessment (FMA) score of their upper extremities was 52.6 ± 13.4 in the stroke patients. The task consisted of 20 runs, and each run is composed of motor execution (800 ms) and rest (500 ms) randomly given by visual cues (see Fig. 1-(A)). The EEG signals were acquired using the NeuroPrax® EEG system (NeuroConn GmbH) with 32 channels. To overcome the limitation of the use of low density EEG, the standardized low resolution brain electromagnetic tomography (sLORETA) was carried out in the source localization analysis. The current source density distribution in brain electrical activity was estimated at 5 nm spatial resolution using sLORETA. To reduce the large variabilities among subjects, a global normalization of the sLORETA images was performed. The EEG data were divided into two frequency bands (alpha: 7.5~12.5 Hz, beta: 18~26 Hz). For the patients with lesions on the right side, the data were flipped from right to left side. We applied two sample *t*-test to find the differences of the subcortical/cortical area between two groups. In the stroke patients, significant subcortical activities ($p < 0.05$) were only observed over the posterior cingulate, the posterior subcortical areas, and limbic lobe in the beta band (see Fig. 1-(B)). In the healthy controls, however, there were no significant activities and areas in the alpha and beta bands.

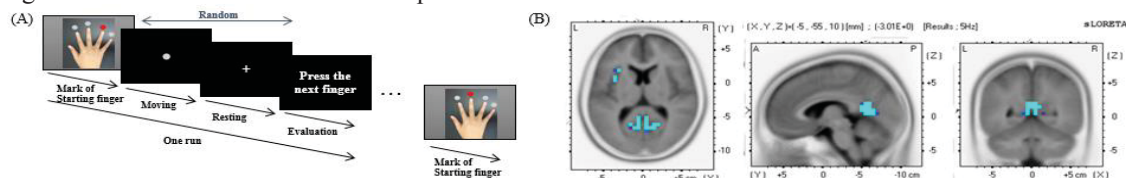


Figure 1. (A) Experimental paradigm, (B) The difference between stroke patients and healthy controls in sLORETA brain activation maps. Cyan color indicates the significant activation areas in the stroke patients compared to the healthy controls ($p < 0.05$).

Discussion: We found the significant differences that have a close relation to motor control circuits using a source localization in the two groups. The posterior cingulate and the posterior subcortical areas are connected with intrinsic control networks including executive motor control [1]. And the limbic lobe is involved in basal ganglia-thalamocortical circuits associated with motor control [2]. The beta band prominently affects disinhibition of neuronal population concerned with motor function compared to the alpha band [3].

Significance: The results showed that the motor control is a meaningful role in the stroke patients with motor disabilities. The differences of subcortical activities between stroke patients and healthy controls can be a new metric for diagnosing and evaluating a degree of motor rehabilitation based on brain-computer interfaces.

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