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IV.10. Handedness and Motor Function - CBF Study -

Kawashima R., Yamada K., Kinomura S., Yamaguchi T., Matsui H. and Fukuda H.

Department of Radiology and Nuclear Medicine, The Research Institute for Tuberculosis and Cancer

Introduction

The left and right hemispheres are differently organized\(^1,2\). Structural hemispherical asymmetries are well known, and the two cerebral hemispheres are supposed to be functionally asymmetric in their motor domain (for instance "handedness"). But functional asymmetry in the motor domain have been infrequently investigated. We have measured the increase in regional cerebral blood flow (rCBF) during simple unilateral hand movement and compared the function of the right and left motor domain cortex in normal subjects.

Materials and Methods

Ten young normal male volunteers were studied. Their ages ranged from 19 to 22 years. The seven subjects were right-handed and the three subjects were left-handed according to the H.N.U.Handedness Inventory\(^3\).

Positron emission tomographic measurements; The subject was placed supine and comfortably on the table of the positron emission tomography (PET) scanner. He did not allow to speak anything and to change respiratory rhythms. His eyes were closed and covered with cotton wool pads, and the room was darkened and kept noiseless for the duration of study. Before the start of measurement, subject was trained to touch his thumb to his fingers by turns. This self-paced unilateral movement was required to move once a second.

The PET system (Model 931/04, CTI Inc.) was employed for all measurement. Subject was inhaled C\(^{15}\)O\(_2\) continuously for 7 min to obtain an equilibrium state, then control scan for 3 min was obtained. After that the subject was instructed to move his one hand. Three min after subject had been moving his hand, 3 min stimulation scans were obtained, while inhalation continues. Then subject was instructed to move his opposite hand and 3 min another stimulation scan were obtained in the same way. The subject was instructed to move his hand all through inhalation continued. The gas was delivered with
air to give concentration of 10 mCi/100ml/min into the subject's mask. PET analysis; To avoid the pain and to move hand smoothly and symmetrically, we eliminated the arterial blood sampling. So we could not calculate the regional cerebral blood flow (rCBF) quantitatively. Thus, rCBF was calculated after scalar normalization neglecting intersubject variation of global CBF (gCBF)\(^4,5\), assuming that because gCBF is constant and independent on the distribution of rCBF\(^4\). Stereotaxic measurements; Prior to the PET scan, each subject received an magnetic resonance imaging (MRI) of his brain. Matching brain slices were performed between the MRI and the PET images\(^6\). Thereafter, the means of rCBF within the structure was computed from the pixel value average for each ROI individually. On the basis of these individual means, the population means rCBF were calculated for each cortical and subcortical ROI. Then the control rest state and each stimulate states were compared using the paired t-test.

Results and Discussion

The mean rCBF of 8 cortical motor domain fields during rest and hand movement states were calculated. The regions that showed statistically significant increase of rCBF by simple hand movement were summarized in Fig.1. When asked to move right hand to ight handed people, the rCBF increased in the right hemisphere of motor cortex (MA), premotor cortex (PMA) and prefrontal cortex (PFA). When asked to move left hand to right handed subjects, the rCBF increased bilaterally in MA and PMA and in the left PFA. Normal subjects should need the activation of the motor domain cortex in the contralateral hemisphere to move dominant hand unilaterally. But the activation of the areas not only in contralateral hemisphere but also in ipsilateral (dominant) hemisphere should be needed to move non-dominant hand, although the movement was very simple. This reflected that the greater effort should be required for normal human to move the non-dominant hand compared to the dominant.

References

RIGHT HANDED  
n = 7

LEFT HANDED  
n = 3

LEFT HAND MOVEMENT  RIGHT HAND MOVEMENT

Fig. 1.