High Order Gustatory Projections in the Human Brain Studied with Positron Emission Tomography

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SUMMARY

The high order gustatory projection of the cerebral hemishere has been studied only with the pathophysiological technique. Therefore, we tried to investigate the cerebral function using a unique technique, positron emission tomography (PET), and the magnetic resonance imaging (MRI) for anatomical reference of the brain.

METHODS

We performed the PET studies using the ^{15}O-CO_2 continuous inhalation method on 5 normal volunteers to investigate the changes of cerebral blood flow (CBF) by the gustatory stimuli. During the studies, the subjects were laid in supine position with their eyes closed under quiet condition. They have a small tube fixed in their mouth and a switch button in their left hand. The studies were started from 7 minutes after the beginning of the inhalation of ^{15}O-CO_2. As a control state, we injected 0.2 ml of pure water into the mouth of the subjects through the small tube every 15 seconds 40 times for 10 minutes. They were instructed to press the button after every 2 injections. We obtained 2 control scans of 5 minutes during these stimuli.

Then, as a stimulation state, we injected 10 % saline and pure water randomly. They were instructed to press the button only after stimulation of saline, which was to make concentration in the discrimination of the gustatory stimulation. We obtained one stimulation scan of 5 minutes. Thereafter we repeated the stimulation scan using saline of lower concentration (0.18 %) to produce more psychic concentration.

Then we evaluated the mean value and standard deviation of difference of pixel values between two control scans. And we extracted those areas as significant which had more pixel values of this subtraction image than that corresponding to 1.96SD of difference between two control scans.

RESULTS

By the stimulation of 10% saline, we found the increase of CBF in the left insular cortex of all 5 cases and in the left thalamus and the right parietal cortex of 4 cases. When treating the right and left hemispheres as one entity, we found the increase in the insular cortex and the thalamus of all 5 cases and in the parahippocampal gyrus and the parietal cortex of 4 cases.

By the stimulation of lighter saline we observed increase of CBF in the right anterior cingulate gyrus of all 5 cases and in the left anterior cingulate gyrus, the right thalamus, and the bilateral parahippocampal gyrus of 4 cases. When neglecting the laterality, the increase of CBF was found in the anterior cingulate gyrus and the thalamus of all 5 cases and in the parahippocampal gyrus and the frontoparietal operculum of 4 cases.

DISCUSSION

In this study, we could extract the regions of the cerebral hemisphere possible for the gustatory related area. The increase of CBF was observed in the areas which were anatomically believed to be high order gustatory projections. These were the thalamus, the ventral posteromedial thalamic nucleus and the cortices arroud the parietal operculum and the insular gustatory area which are the projections of the third neurons. Also we found the cingulate gyrus and the parahippocampal gyrus during gustatory discrimination task. In this study, we extracted those areas neglecting laterality, because the gustatory stimulation was given on both right and left side. However, there remains possibility of the right left diferences in the gustatory discrimination as the high order association function.