Gustatory Stimulated Areas Detected With 150-C02 / PET Technique

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IV. 1. Gustatory Stimulated Areas Detected With ^{15}O-CO_2 / PET Technique

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Introduction

High order gustatory projection of the brain has been studied commonly in monkeys and other animals with electrophysiological technique which was required to insert the electrode into the brain. So, that technique cannot be applied to humans. Therefore, we tried to investigate the brain function using continuous ^{15}O-CO_2 inhalation method with PET in human being.

Methods

We performed PET studies using the ^{15}O-CO_2 continuous inhalation method and PT931/04 positron camera (CTI Inc. Noxville USA). First of all, to validate availability of ^{15}O-CO_2/PET technic, we investigated activated areas under visual stimulation well-known foci in the brain. Five normal volunteers (male, age 19-21 yrs) were studied. Seven minutes after starting inhalation of ^{15}O-CO_2 gas, 8 sets of 2-minutes scans were performed. The former 4 scans were obtained with their eyes closed, and the latter 4 scans with their eyes open to watch marker light, respectively. The circular ROIs (10 mm diameter) were put on the visual cortex of each image and the percent radioactivity to mean whole brain activity during the study was plotted against time.

Next, we performed gustatory stimulation study on eight normal volunteers (male, age 18-23 yrs) to investigate the changes of cerebral radioactivity by the gustatory stimuli. During the studies, the subjects were laid in supine position with their eyes closed under quiet condition. They have small tubes 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 under these condition. Then, as a stimulation state, we injected 0.18 % saline and pure water

randomly. They were instructed to concentrate on the discrimination of the gustatory stimulation by pressing the button only after stimulation of saline. We obtained one stimulation scan of 5 minutes. Thereafter we repeated the stimulation scan using 10 % saline. We subtracted control images from stimulated images,then we calculated the mean and SD of pixel values of the subtraction image in the whole brain. We extracted areas of which counts were increased more than 1.96 SD of mean value in the whole brain as the stimulated areas. Those areas were superimposed on the MRI of the same slice level.

Results

In the visual stimulation study, percent radioactivity in the visual cortex under eyes closed was constant throughout the 4 continuous scans and 128.0±13.5 % of mean whole brain activity. In the first scan just after beginning of visual stimulation, an increase of percent radioactivity in visual cortex was detected. During visual stimulation, percent radioactivity in the visual cortex was constant throughout 4 scans and 157.5±19.6 %. By the visual stimulations,we found 29.2±12.0 % increase of percent radioactivity in visual cortex. The percent radioactivity to mean whole brain activity during the study was plotted against time in Fig .

In the stimulation study of saline, anatomical areas of increased radioactivity were thalamus, Insular cortex, frontpoarietal cortex, anterior cingulate gyrus and parahippocampal gyrus . It is summerized in Table .

Conclusion

In this study we could detect onset of brain function by visual stimulation within 2 minutes time resolution. We could conclude that ^{15}O-CO_2/PET technic was available to detect the activated areas. And we could extract the regions, such as thalamus, insula, and frontparietal operculum which were quoted in literature as possible gustatory related areas of animals. Additionally, we found the anterior cingulate gyrus and parahippocampal gyrus possible as the higher order projection which related to discrimination.

Table. 1. By the stimulation study of saline, anatomical areas of increased radioactivity were shown.

	0.18% Saline	*10% Saline*
Thalamus	*6 cases of 8*	*7 cases of 8*
Insula	*5 cases of 8*	*7 cases of 8*
Frontoparietal Operculum	*5 cases of 8*	*4 cases of 8*
Anterior Cingulate Gyrus	*7 cases of 8*	*6 cases of 8*
Parahippocampal Gyrus	*6 cases of 8*	*6 cases of 8*

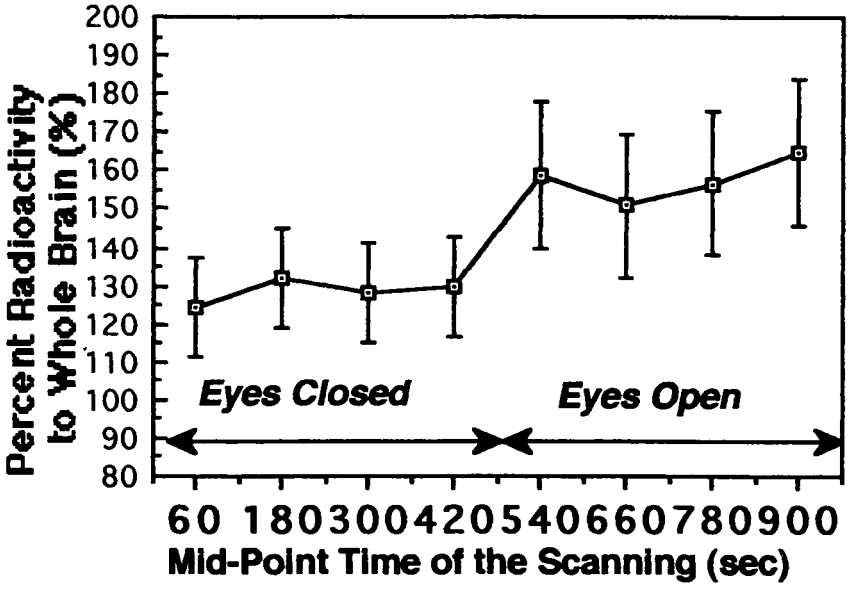

Fig. 1. The sequential changes of radioactivity in the visual cortex. The horizontal axis showing mid-point time of scan, the vertical axis showing percent radioactivity to whole brain. We found 29.2± 12.0 % increase of percent radioactivity in the cortex.