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Abnormal neuronal network in anorexia nervosa studied with I-123-IMP SPECT

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Abstract

Single photon emission computed tomography was used to study 14 female patients with anorexia nervosa and 8 female normal comparison subjects. Automatic voxel-based analysis of the images was carried out using statistical parametric mapping (SPM) software. Statistics across the entire brain were displayed as Z scores (threshold: $P < 0.05$). Compared with the normal comparison subjects, the anorectic patients were characterized by hypoperfusion in the medial prefrontal cortex and the anterior cingulate gyrus, and hyperperfusion in the thalamus and the amygdala–hippocampus complex. These results suggest that a dysfunction in neuronal circuitry may be related to anorexia nervosa.

Keywords: Eating disorder; Cerebral blood flow; Frontal cortex; Thalamus; Temporal lobe

1. Introduction

The etiology of anorexia nervosa is not yet understood but is thought to involve multifactoral, including biological substrates. A number of metabolic and endocrine abnormalities, mainly at the hypothalamic level, have been described in anorexia nervosa (Gwirtsman and Gerner, 1981; Wakeling, 1985). Non-invasive techniques such as positron emission tomography (PET), single photon emission computed tomography (SPECT), and functional magnetic resonance imaging (fMRI) have been used to evaluate cerebral functioning in the disorder. A PET study revealed increased metabolism of the caudate nucleus in the anorexic state that returned to normal levels after realimentation (Herholz et al., 1987). In a SPECT study with [^{99m}Tc]-D,L-hexamethyl-propylene amine oxime (HM-PAO), changes in cerebral blood flow in response to food-intake stimuli were

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observed in the inferior frontal cortex, superior frontal cortex and occipital cortex (Nozoe et al., 1993). A recent fMRI study related activity in the anterior cingulate gyrus (ACG), the left insula, and the amygdala–hippocampus complex to calorie fear in anorexia nervosa (Ellison et al., 1998). In the present study, we used statistical parametric mapping (SPM) to compare cerebral perfusion in patients with anorexia nervosa and healthy volunteers.

2. Methods

2.1. Clinical data

Fourteen right-handed women with anorexia nervosa (mean age = 21.2, S.D. = 6.6 years) and eight right-handed normal women (mean age = 28.1, S.D. = 3.4 years) underwent brain SPECT scans with [^{123}I]-iodoamphetamine (I-123-IMP). Between December 1997 and November 1999, the patients were recruited from the Department of Psychiatry, Hokkaido University School of Medicine, and the normal subjects were recruited from workers in the same hospital. The normal subjects were free of any history of alcohol or drug abuse, major psychiatric disorder, medical illness, or family history of psychiatric disorder.

Diagnoses of anorexia nervosa were made according to DSM-IV criteria (American Psychiatric Association, 1994) (Table 1). The patients were divided into restricting ($n = 8$) and binge-eating/purging ($n = 6$) subtypes. The patients did not have any co-morbid psychiatric disorders, including secondary major depression. On the day of the SPECT scans, the Hamilton Rating Scale for Depression (Hamilton, 1967) was used to evaluate the patients.

Table 1
Clinical characteristics of the subjects

	Anorexia nervosa	Control
Number	14	8
Age (years)	21.2 ± 6.6	28.3 ± 3.3
Height (m)	1.58 ± 0.06	1.57 ± 0.05
Weight (kg)	34.8 ± 5.4	48.4 ± 3.7
BMI	14.0 ± 2.2	19.7 ± 0.8
HRSD score	8.9 ± 3.6	N.P.
Duration of illness (years)	1.4 ± 0.8	None

Values are given as mean ± S.D. N.P., not performed.

Magnetic resonance images were visually inspected by an experienced radiologist, blind to psychiatric diagnosis, who ruled out the presence of moderate atrophy or other structural changes in each subject. All subjects provided informed consent to participate in this study.

2.2. SPECT procedures

All subjects were injected with 167 MBq of I-123-IMP while they were in a supine resting state with their eyes closed in a quiet, dimly lit room. After 20 min, brain SPECT scanning was performed for 20 min by use of a triple detector gamma camera (GCA-9300; Toshiba Medical Inc., Japan) equipped with low-energy, high-resolution fan-beam collimators. Transaxial images were obtained by filtered back-projection methods with a Butterworth filter (order 8, cutoff frequency of 0.1 pixel/cycle), and attenuation correction was performed with Chang's method. An attenuation correction coefficient of 0.10 was used. Images were acquired and displayed on a 128×128 matrix. The spatial resolution was 10 mm full-width half-maximum after reconstruction.

2.3. Image analysis

Data were analyzed using SPM96 for Windows software (Friston et al., 1996). Statistical parametric maps are spatially extended statistical processes and were used to characterize regionally specific effects in the imaging data. Templates for I-123-IMP were derived from 10 averaged normal control images. Statistical parametric mapping (SPM) combines the general linear model and the theory of Gaussian fields to make statistical inferences about regional effects (Friston et al., 1991). To examine the images for specific regions showing differences in perfusion, two comparisons were performed. The first examined areas of increased perfusion, and the second examined areas of decreased perfusion. Global perfusion differences were accounted for