^{99m}Tc-ECD brain SPECT imaging in patients with acquired immunodeficiency syndromes

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Abstract In order to investigate the changes of regional cerebral blood flow (rCBF) in patients with acquired immunodeficiency syndromes (AIDS), ^{99m}Tc-ECD brain SPECT imaging was performed in 5 patients with AIDS and 16 sex and age matched normal controls, and the rCBF percentages compared to the cerebellum were calculated using a semi-quantitative processing software. Hypoperfusions in the right and left frontal, temporal, porietal lobe, basal ganglia and left thalamus were seen in 1 patient with dementia. Hypoperfusions in the right and left frontal and temporal lobe were seen in 4 asymptomatic patients. The rCBF in the right and left frontal, temporal, porietal lobe, basal ganglia and thalamus, front and pons were decreased significantly in patients with AIDS than those of the control subjects (p <0.005). It is concluded that there exists reduced cortico-subcortical rCBF in AIDS patients.

Keywords Acquired immunodeficiency syndromes, Brain, Single photon emission computed tomography, ^{99m}Tc-ECD

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1 INTRODUCTION

Clinically, patients with acquired immunodeficiency syndromes (AIDS) dementia complex (ADC) develop progressive cognitive impairment and motor dysfunction.[1] Morphologic imaging, such as CT or MRI, is able to quantify in vivo structural changes occurring in gray and white matter in severe patients with ADC.[2] However, structural abnormalities by using CT or MRI are often absent during the early stages of AIDS. Imaging techniques, such as SPECT or PET, that evaluate for physiologic or biochemical changes may be more sensitive for assessing the severity of brain injury than structural neuroimaging. This aim of this study was to investigate the changes of regional cerebral blood flow (rCBF) in patients with AIDS using SPECT.

2 MATERIALS AND METHODS

2.1 Subjects

Five male patients between 31 and 37 years of age (mean 34 years) with AIDS were included in the study. The diagnosis of AIDS was made according to the criteria of the

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American Centers for Disease Control (CDC) and based on the patients history, clinical observation and laboratory data including HIV serology.[3] The distribution of patients according to the stages of AIDS (CDC classification) was: 5 in stage IV. Cognitive impairment was rated, using a modification of the criteria given by Navia *et al.*,[4] as 0 (normal cognition), 1 (mild attentional deficit or difficulty with forward planning), 2 (moderate attentional deficit and / or mild memory loss, with ability to perform activities of daily living), 3 (severe impairment in multiple areas of cognition, precluding performance of activities of daily living). Clinical characteristics of patients with AIDS are shown in Table 1.

For comparison with patients ^{99m}Tc-ECD brain SPECT imaging, we had the results of 16 sex and age matched normal controls between 21 and 48 years of age (mean 37 years). Clinical examination did not reveal any neurological disorders in any of those healthy subjects.

2.2 Brain SPECT imaging

The patients were placed in a supine position in a quiet, dimmed room with their eyes closed. After 5–10 minutes the radiopharmaceutical ^{99m}Tc-ECD 740-925 MBq was injected. The data acquisition was started 30 minutes later. Image data were acquired using a two-head SPECT (Elscint APEX SPX HELIX, General Electric Medical Systems, USA). By applying a step and shoot procedure for every 6°, 60 projections were taken in 25-30s per frame to a 128×128 matrix. Fan-beam Collimators were employed. The raw data were reconstructed in the computer workstation (Xpert, General Electric Medical Systems, USA) by the method of filtered back projection, using a Henning filters, and an attenuation correction (linear 0.11 cm^{-1}) was performed. Transverse, sagittal and coronal slices were reconstructed. The SPECT images were qualitatively evaluated by two nuclear medicine physicians blinded to the clinical status of the patients. The rCBF percentage compared to the cerebellum were calculated using a semi-quantitative processing software (Semi-Quantitative Brain Following Slicing, General Electric Medical Systems, USA).

2.3 Statistical analysis

Comparisons of mean values between patients and normal controls subgroups were performed using the student t-test. A p-value of 0.05 or less was considered significant.

3 RESULTS

The ^{99m}Tc-ECD SPECT images of 5 patients with AIDS showed changes in regional brain perfusion (see Table 1). Fig.1 shows typical hypoperfusion pattern in one patient with dementia. Table 2 shows the results of semi-quantitative analysis of rCBF in patients with AIDS and normal subjects. The rCBF in the right and left frontal, temporal, porietal lobe, basal ganglia and thalamus, front and pons were decreased significantly in patients with AIDS than those of the control subjects (p <0.01).

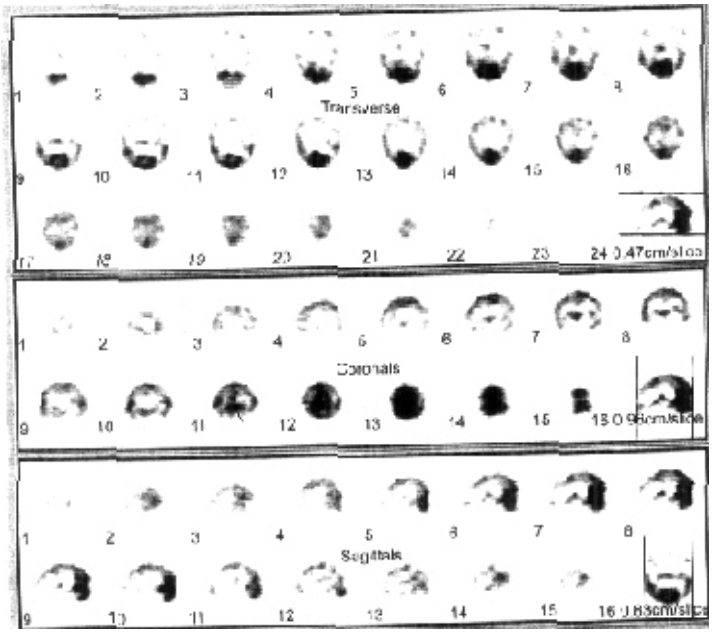

Fig.1 For a 37-year-old man with AIDS (IV), ^{99m}Tc-ECD SPECT image reveals regional hypoperfusion in the bilateral frontal, parietal, temporal lobe and the basal ganglia, decreased uptake in the left thalamus.

Table 1 Clinical data and abnormality in SPECT image of patients with AIDS

Case	Sex	Age (year)	CDC	HIV infections	Cognition scores	Dementia	CT	SPECT findings
1	M	31	IV	Sexual contact	0	No	–	Decreased uptake in the bilateral frontal lobe
2	M	37	IV	Sexual contact	2	Yes	Brain atrophy	Decreased uptake in the bilateral frontal, parietal, temporal lobe and the basal ganglia, decreased uptake in the left thalamus
3	M	34	IV	Intravenous drug use	0	No	–	Decreased uptake in the bilateral frontal and parietal lobe
4	M	36	IV	Intravenous drug use	0	No	–	Decreased uptake in the bilateral frontal and parietal lobe
5	M	34	IV	Intravenous drug use	0	No	–	Decreased uptake in the bilateral frontal and parietal lobe

Table 2 The results of rCBF in patients with AIDS and normal subjects $(\bar{x} \pm s)$

Group	n	Cerebellum			Frontal		
		R(%)	L(%)	R/L	R(%)	L(%)	R/L
AIDS	5	98.4±2.6	97.8±2.9	1.00±0.05	52.6±3.8	48.3±2.6	1.09±0.06
Control	16	97.6±3.7	97.9±3.0	0.99±0.06	65.1±4.1	64.2±3.4	1.02±0.03
t-value		0.445	0.089	0.244	6.075[1]	9.548[1]	3.642[1]

Group	n	Parietal			Occipital		
		R(%)	L(%)	R/L	R(%)	L(%)	R/L
AIDS	5	56.4±5.1	53.8±5.2	1.05±0.11	71.8±5.1	70.3±3.5	1.03±0.08
Control	16	66.6±4.1	65.8±3.4	1.01±0.09	74.5±5.7	74.4±5.8	1.01±0.04
t-value		4.597[1]	6.058[1]	1.451	0.942	1.499	0.695

Group	n	Temporal			Basal ganglia		
		R(%)	L(%)	R/L	R(%)	L(%)	R/L
AIDS	5	49.2±3.8	48.7±4.0	1.01±0.03	61.0±9.8	58.8±8.1	1.03±0.08
Control	16	59.9±3.3	60.3±3.5	1.00±0.04	75.9±6.0	74.8±5.9	1.02±0.06
t-value		6.110[1]	6.240[1]	0.561	4.188[1]	4.859[1]	0.583

Group	n	Thalamus			Front (%)	Pons(%)
		R(%)	L(%)	R/L		
AIDS	5	60.4±2.5	59.6±3.1	1.02±0.07	44.4±6.1	39.4±5.9[1]
Control	16	74.9±6.2	75.4±6.6	0.99±0.04	61.3±8.6	49.1±1.2
t-value		5.032[1]	5.125[1]	0.978	4.053[1]	3.676[1]

[1] $p < 0.01$

4 DISCUSSION

In this study, hypoperfusions in the right and left frontal, temporal, porietal lobe, basal ganglia and left thalamus were seen in 1 patient with dementia. Regional hypoperfusions in the right and left frontal and temporal lobe were seen in 4 asymptomatic patients. The rCBF values in the right and left frontal, temporal, porietal lobe, basal ganglia and thalamus, front and pons were decreased significantly in patients with AIDS than those of the control subjects ($p < 0.01$). These findings suggest that there is reduced cortico-subcortical rCBF in patients with AIDS. SPECT abnormalities correspond with the severity of dementia. The rCBF deficits may be apparent in early stages of AIDS when the patient is relatively asymptomatic and structural neuroimaging is negative. Our results are consistent with previous findings from SPECT with ^{123}I-IMP and ^{99m}Tc-HMPAO.[5-8] Although the reason for the cortico-subcortical regional hypoperfusion in AIDS dementia complex is unknown, previous neuropathologic studies reported neuronal loss in various brain regions in patients with AIDS dementia complex.[9] HIV-associated brain injury is hypothesized to result not only from HIV-1 viral proteins (gp120 or Tat) but also from secondary factors, such as chemokines and cytokines (tumor necrosis factor

alpha, macrophage chemotactic protein-1),[10,11] these factors also may be responsible for the alteration of cortico-subcortical rCBF. Future studies are needed to evaluate the relationships between these secondary factors and the degree of rCBF alterations.

It is clear that SPECT may be of help in the early diagnosis of dementia, given that rCBF SPECT imaging is more sensitive than structural neuroimaging in the detection of cerebral abnormality in the degenerative brain disease. However, many of the rCBF patterns encountered in dementia are common to a number of different disorders, and it is unclear whether SPECT is able to differentiate between the various dementing conditions. For example, bilateral temporoparietal rCBF deficits are seen in Alzheimer's disease, Parkinson's disease, Lewy body dementia, AIDS dementia complex, neurosyphilis and vascular dementia. These observations from SPECT indicate that certain patterns of rCBF abnormality are not specific for any particular disorder. Consequently, it may appear that the contribution SPECT can provide to the differentiation of dementia is very limited.[7] However, these limitations can be overcome provided that SPECT images are interpreted in the light of neuropsychological evaluation, neurological features and structural neuroimaging. For example, AIDS is diagnosed with HIV serological test.

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