行政院國家科學委員會專題研究計畫　成果報告

使用鍀-99m ECD 腦血流單光子射出電腦斷層造影來評估急性一氧化碳中毒病人的神經學併發症

計畫類別：個別型計畫
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計畫主持人：孫盛生

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行政院國家科學委員會補助專題研究計畫 ■成果報告 □期中進度報告

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中文摘要

鎝-99 m ECD 單光子射出斷層掃描是用來偵測急性一氧化碳中毒患者的局部腦血流。十位過去沒有精神疾病的急性一氧化碳中毒患者被納入這個研究中。這十位患者在經過氧氣治療後皆進行鎝-99 m ECD 單光子射出斷層掃描和腦部電腦斷層掃描。所有的腦部電腦斷層掃描的結果都正常；而鎝-99 m ECD 單光子射出斷層掃描發現有五位患者有基底核的血流減少七位患者有腦部皮質的血流減少，只有三位患者的鎝-99 m ECD 單光子射出斷層掃描的結果都正常。這個研究顯示鎝-99 m ECD 單光子射出斷層掃描比腦部電腦斷層掃描更能早期偵測出急性一氧化碳中毒患者腦部血流減少的位置。

關鍵字

鎝-99 m ECD，單光子射出斷層掃描，局部腦血流，一氧化碳中毒

英文摘要

Technetium-99m ethyl cysteinate dimer (Tc-99m ECD) brain single photon emission computed tomography (SPECT) was used to detect abnormal regional cerebral blood flow (rCBF) in patients with acute carbon monoxide (CO) poisoning. Ten patients with acute CO poisoning and no past histories of psychoneurologic disorders were enrolled in this study. After oxygen treatment, all of the 10 patients were investigated using Tc-99m ECD brain SPECT and brain computed tomography (CT) scan. Brain CT scan findings were normal in all of the 10 patients. Tc-99m ECD brain SPECT demonstrated hypoperfusion lesions of the basal ganglia and brain cortex in 5 and 7 patients, respectively. Only 3 of the 10 patients had normal Tc-99m ECD brain SPECT findings. This study suggests that, in comparison with brain CT scan, Tc-99m ECD brain SPECT is a better tool to early detect hypoperfusion brain lesions in acute CO poisoning with normal brain CT findings.

Keywords

Technetium-99m ethyl cysteinate dimmer, single photon emission computed tomography, regional cerebral blood flow, carbon monoxide poisoning

Introduction

Acute carbon monoxide (CO) poisoning causes a wide variety of psychoneurologic disorders [1-4], which cannot be predicted in the acute phase by clinical, EEG, or brain computed tomography (CT) findings [1,3,4]. The most common neuropathologic findings in acute and delayed CO encephalopathy are ischemia and necrosis of basal ganglia (globi pallidi). Less frequent findings include spongy necrosis of cerebral cortex. Damage in the globi pallidi and cerebral cortex can usually be demonstrated by serial brain CT scan [5-8]. However, structural changes are not usually used as diagnosis or treatment criteria in CO poisoning [1,3,4]. Therefore, brain single photon emission tomography (SPECT) with technetium-99m hexamethylpropylene amine oxime (Tc-99m HMPAO) was used to assess regional cerebral blood flow (rCBF) in patients with CO poisoning and normal brain CT findings [9].

However, Tc-99m HMPAO has to be injected within 30 min after preparation due to its rapid decomposition in vitro and at least delayed 40 min after injection waiting for background clearance is necessary to get interpretable SPECT imaging. Therefore, Tc-99m HMPAO SPECT to assess rCBF in patients was limited in general clinical practice [10]. Technetium-99m ethyl cysteinate dimer (Tc-99m ECD) is presently under clinical evaluation as a newer agent of rCBF, but without the problems of radiochemical instability and delayed imaging [11]. To date, no complete reports have been published concerning the clinical application of Tc-99m ECD brain SPECT to evaluate rCBF in patients with CO poisoning. Therefore, in the preliminary report, we used Tc-99m ECD brain SPECT to evaluate patients with CO poisoning and normal brain CT findings.

Patients and Methods

Patients. Ten consecutive patients (6 females, 4 males, aged 18 - 35 years) with acute CO poisoning and no past history of psychoneurologic disorders were enrolled in this study. When the CO poisoned patients were found, they were transferred to our emergency room immediately (the interval was 0.5 - 1 hour). Upon admission, 7 of the 10 patients had active psychoneurologic symptoms/signs. Toxicology screens were performed to rule out poisoning from other drugs or chemicals. Blood COHb values were measured immediately and hyperbaric oxygen therapy was administered. After hyperbaric oxygen therapy, all patients had normal blood COHb values and no psychoneurologic symptoms/signs. Within 2 to 5 hours after CO poisoning, all of

the 10 patients were investigated using Tc-99m ECD brain SPECT and brain CT scan for comparison.

Tc-99m ECD brain SPECT. After the brain CT scan was performed, each patient received Tc-99m ECD brain SPECT. Tc-99m ECD was prepared according to the formula of a commercial vial (Neurolite, Dupont Company, USA). The radiochemical purity of the final Tc-99m ECD complex was measured by thin-layer chromatography on Whatman MKC 18 plates developed with acetone and 0.5 M ammonium acetate (60:40). The radiochemical purity was calculated by comparing the peak for the Tc-99m ECD complex to the sum of all other peaks on the plate [11]. The radiochemical purities of Tc-99m ECD were higher than 97%. Tc-99m ECD (740 MBq) was intravenously injected in a dark and quiet room. The position of the patient's head was fixed and maintained during SPECT imaging using a hemicylindrical plastic headholder with a radiolucent plastic neck-contoured-head rest. Fifteen to 45 min after intravenous Tc-99m ECD injection, SPECT data were obtained using a dual-headed gamma camera equipped with fan-beam collimators. Data were collected from 120 projections per 3 angular sampling in the 140 keV photo-peak over 360° (180° for each head) in 128 × 128 matrices, with an acquisition time of 30 seconds per projection in a step and shoot mode. A zoom factor of 1.46 was used. After data acquisition, the data were normalized for the decay of Tc-99m from the first to last frame. The counts within each frames of SPECT were the same. For SPECT images, the transaxial, coronal and sagittal slices were reconstructed. To identify areas of abnormal perfusion, visual interpretation of the SPECT images from each patient was carried out in random order by the agreement of at least two of three independent experienced observers alongside images from healthy controls, unaware that the images were from a cohort of patients with CO poisoning, and blind to the other clinical information. Normal Tc-99m ECD brain SPECT findings consisted of homogenous rCBF in the gray matter of brain cortex and basal ganglia without hypoperfusion lesions or visible asymmetry. Abnormal findings included heterogeneous rCBF with hypoperfusion lesions or visible asymmetry on at least two consecutive slices.

Results

The detailed results of the patients are shown in Table 1. Brain CT scans were normal in all of the 10 patients. Seven of the 10 (70%) patients had hypoperfusion brain lesions on Tc-99m ECD brain SPECT. There were 5 (50%) patients with hypoperfusions lesion of basal ganglia and 7 (70%) patients with hypoperfusion

lesions of brain cortex. The most common hypoperfusion brain lesions areas were the parietal lobes (Table 2). In addition, the 5 patients with hypoperfusion lesions in the basal ganglia developed symptoms/signs of parkinsonism, and 2 patients with hypoperfusion lesions in the occipital lobes developed blurred vision. However, all of the 3 patients (100%) without hypoperfusion brain lesions did not develop any neuropsychiatric sequelae. All of the 7 patients with positive Tc-99m ECD brain SPECT findings had high COHb values (>4.0%) and severe psychoneurologic symptoms/signs (loss of consciousness) upon admission (p value < 0.05, by a Fisher Exact test).

Discussion

In a review of the literature, two previous studies using Tc-99m HMPAO brain SPECT reported hypoperfusion brain lesions in 8 of 10 (80%) and 5 of 12 (42%), respectively, patients with acute CO poisoning [9,12]. The results are in agreement with the findings of a few available cerebral perfusion studies follows CO poisoning [12-14]. Our results (70%) are similar to one of the previous study [9], but with better sensitivity than the other previous study [12].

Hypoactivity or necrosis of basal ganglia (globi pallidi) is highly suggestive of CO poisoning [5]. However, in previous studies, hypoperfusion lesions located in the cerebral cortex could be demonstrated, while hypoperfusion lesions within basal ganglia could not be detected [12,14]. In our study, there were 5 (50%) patients with hypoperfusions lesion of basal ganglia and 7 (70%) patients with hypoperfusion lesions of brain cortex. The most common hypoperfusion brain lesions areas were the parietal lobes (Table 2). Because we could not perform psychometric tests associated parietal/temporal abnormalities such as the Wechsler Adult Intelligence Scale, the Boston Naming test, and Benton's Visual Retention Test [15] in confusion or disorientation patients (Table 1), so that there are no data concerning impaired parietal/temporal rCBF and neuropsychologic changes in the patients with CO poisoning. In addition, the 5 patients with hypoperfusion lesions in the basal ganglia developed symptoms/signs of parkinsonism, and 2 patients with hypoperfusion lesions in the occipital lobes developed blurred vision. Focal cerebral cortical hypoperfusion is relatively nonspecific. Similar hypoperfusion anomalies in the cerebral cortex can be found in a variety of acute psychoneurologic disorders, including postanoxic syndrome due to cardiac arrest, hypoglycemia, cerebral infarction, multi-infarct dementia, Alzheimer's and Parkinson's disease [14,16]. Therefore, in loss of consciousness of unknown origin, Tc-99m ECD brain SPECT would not provide great help in the retrospective diagnosis of CO poisoning.

There were controversial results of relationship between Tc-99m ECD brain SPECT findings to blood CO level and clinical signs of acute CO poisoning at admission [9,12]. However, we found that the patients with high COHb values and severe psychoneurologic symptoms/signs (loss of consciousness) upon admission had a high incidence of positive Tc-99m ECD brain SPECT findings.

Based on our preliminary results, Tc-99m ECD brain SPECT is more sensitive than brain CT scan and can predict patients' neuropsychiatric sequelae, therefore Tc-99m ECD brain SPECT should be a potential implement to evaluate hypoperfusion brain lesions in patients with acute CO poisoning and normal brain CT scan findings. However, further studies with a larger series of study subjects are necessary.

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Table 1. The detailed results of our patients.

Patient No.	Sex	Age (Years)	Psychoneurologic Symptoms/Signs at Admission	COHb Values (%)	Hypoperfusion Lesions on Tc-99m ECD Brain SPECT	Neuropsychiatric Sequelae
1	F	18	Loss of Consciousness	12.5	Bil-P-T-B	Parkinsonism, Disorientation, Memory impairment
2	M	20	Loss of Consciousness	11.3	Bil-P	Confusion, Memory impairment
3	M	21	None	1.7	N	None
4	F	23	Loss of Consciousness	9.8	Bil-O-B, Rt-F, Lt-P-T	Parkinsonism, Confusion, Blurred Vision
5	F	25	Loss of Consciousness	12.7	Rt-T-O, Lt-P-B	Parkinsonism, Disorientation, Blurred Vision
6	M	26	Headache	3.2	Lt-F-P-C	Disorientation, Memory impairment, Blurred Vision
7	F	28	Loss of Consciousness	7.2	Lt-T-B	Parkinsonism, Confusion, Memory impairment
8	F	30	Loss of Consciousness	6.5	Bil-F-P-B	Parkinsonism
9	M	32	Drowsy	1.2	N	None
10	F	35	Dizziness	2.8	N	None

M, male; F, female; Bil, bilateral; Lt, left side; Rt, right side; F, frontal lobe; P, parietal lobe; T, temporal lobe; O, occipital lobe; B, basal ganglia; C, cerebellum; N, negative.

Table 2. The detailed findings of Tc-99m ECD brain SPECT.

	Hypoperfusion Lesions on Tc-99m ECD Brain SPECT						
	Frontal lobe	Parietal lobe	Temporal lobe	Occipital lobe	Basal ganglia	Cerebellum	Total
Case No.	3	6	4	2	5	1	7
(%)	30%	60%	40%	20%	50%	10%	70%