Scintigraphic Evaluation of Brain Death with ^{99m}Tc -*d,l*-Hexamethyl-propyleneamine Oxime (HMPAO)

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*Lately, the criteria of brain death is being discussed. Cerebral scintigram, especially scintigraphic evaluation of brain death by dynamic study, has been previously reported. Cerebral imaging using radiolabeled amines such as ^{123}I -IMP N-isopropyl-p-iodoamphetamine (IMP) or ^{99m}Tc *d,l*-hexamethyl-propyleneamine oxime (HMPAO) offers a significant information of brain death by the finding of "non visualized brain". However, the dynamic scintigram acquired during the bolus injection of ^{99m}Tc -HMPAO provides an additional information of brain death by classical "hot nose sign". ^{99m}Tc -HMPAO is able to be administered relatively in a large amount of dose. This cerebral perfusion tracer is lipophilic and remains in the central nervous system, which characterize its role as an reliable indicator of cerebral blood flow. As a result, this compound became suitable for the non-invasive study of brain circulation when the diagnosis of brain death is uncertain. We report a case of brain death in which diagnosis was made by the classical "hot nose sign" in dynamic scintigraphy performed when ^{99m}Tc -HMPAO was injected as well as the SPECT which showed a lack of cerebral visualization at the equilibrium state. As far as we are informed, this additional procedure used in the diagnosis of brain death has not reported before. The importance of performing a dynamic scintigram at the administration of ^{99m}Tc -HMPAO is also discussed in this report.*

Key Words: brain death, technetium-99m-*d,l*-hexamethyl-propyleneamine oxime, dynamic scintigraphy, hot nose sign, single photon emission computed tomography

Case Report

An 80 year old female awoke early in the morning with headache. Walking to the bath room, she became unconscious for about an hour. A private physician was called and cerebrovascular accident was suspected. She was referred to Department of Neurosurgery at our General Hospital.

As her past history, she was operated for thoracic intervertebral disk herniation 6 years prior to the admission. 5 years before admission, she underwent subtotal gastrectomy for

gastric ulcer.

Physical examinations revealed 15 of Glasgow Coma Scale and bilateral ocular fundal hemorrhage. Although her motor weakness was not clearly positive, neck rigidity was obviously recognized.

Cranial CT was performed, which demonstrated subarachnoidal hemorrhage and enlarged ventricle. Cerebral angiography disclosed an aneurysm at anterior communicating artery.

Although she was evaluated as being in the state of Grade 1 SAH, operation was delayed considering her age. At 10:00 A.M. on the

7th day, she complained of headache again, when CT examination was repeated. She became unconscious at 11:45 A.M. and was intubated. However, no significant change was observed on the repeated CT (Fig. 1a). After the CT examination, spontaneous respiration became weak and blood pressure began to decrease.

Dynamic scintigram acquired during the bolus injection of 925 MBq (25 mCi) of ^{99m}Tc HMPAO well demonstrated lack of influx of radionuclides into the intracranium (Fig. 1b). Single photon emission computed tomography (SPECT) following the dynamic study presented "non-visualization of the brain" (Fig. 1c). At this point, bilateral pupils were dilated. After the cerebral scintigram was performed, blood pressure decreased more. At noon on the next day, cessation of the cardiac function was confirmed. At autopsy, subarachnoidal hemorrhage, especially around the brain stem and the cere-

Fig. 1 a CT performed at the second attack. High density level is discriminated in the posterior horn of right lateral ventricle together with the high density of the arachnoid space around right Sylvian fissure

Fig. 1 b Radionuclide angiogram acquired with a bolus injection of ^{99m}Tc -HMPAO (1 frame/second) revealed no cerebral perfusion. Classical "HOT NOSE SIGN" is demonstrated

Fig. 1 c Sagittal SPECT images at equilibrium state shows no radioactivity in the intracranium.

bral edema were proved. Aneurysm was found in anterior cerebral artery. There was no vascular spasm. Rupture of anterior communicating aneurysm was suspected to have caused her death.

Discussion

It is proper to make a diagnosis of brain death immediately when cerebral circulation ceases, however, there is no standard system for the confirmation of the cessation of cerebral circulation. So far, many attempts to confirm brain death have been reported. Electroencephalogram including brain stem auditory evoked response¹⁾, cerebral angiography with or without DSA²⁾, cerebral dynamic CT³⁾, cerebral blood flow estimation by Doppler ultrasonography⁴⁾ and/or cerebral dynamic scintigraphy⁵⁾⁻⁷⁾ were reported. However, discrepancies among these examinations at the same patient were also reported^{8),9)}. Because of the absence of definite criterion, we are obliged to make a diagnosis of brain death generally using various kinds of examinations.

Under these circumstances, scintigraphic evaluations of brain death by following radio-labeled amines as ^{123}I -IMP or ^{99m}Tc -HMPAO have been performed^{10),11)}. The scintigraphic findings of brain death using these tracers are the lack of visualization of the brain, which reflects the cessation of cerebral blood flow. It is known that dynamic study using ^{123}I -IMP is inappropriate because of its limitation of the administrative dose. IMP studies combined with scintigram with ^{99m}Tc sodium pertechnetate or ^{99m}Tc diethylenetriaminepentaacetic acid (^{99m}Tc -DTPA) are reported, however, IMP study could not be performed simultaneously because of the radioactivity of ^{99m}Tc . On the other hand, radionuclide examination with ^{99m}Tc -HMPAO is more beneficial than that by ^{123}I -IMP in terms of its amount of information. And that, the ^{99m}Tc -HMPAO is always available because its labeling is simply performed. This advantage could be critical when the transplantation is planned with the organs of brain dead patients. As mentioned above, there is no confirming clue to brain death, so more informative radionuclide tracer is better in its diagnosis. Hot nose sign^{12),13)} demonstrated by dynamic study performed while the administration of ^{99m}Tc -HMPAO is assured by the lack of cerebral visualization by SPECT. These two find-

ings further support the diagnosis of brain death. And moreover, in other words, dynamic study prior to SPECT is essential because ^{99m}Tc -HMPAO is unstable after it is labeled. We actually experienced a case whose cranium as well as brain were visualized by scintigraphy with ^{99m}Tc -HMPAO because of a prolonged interval between the labeling of the HMPAO and its intravenous injection. It was considered to be due to the existence of free ^{99m}Tc from degraded tracers. When only cranium is visualized like a brain dead patient, dynamic study at intravenous injection assures the lack of intracranial perfusion. Mis-labeled brain scintigram would be excluded.

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要 旨

**^{99m}Tc -*d,l*-Hexamethyl-propyleneamine Oxime(HMPAO)を用いた
脳死のシンチグラフィによる評価**

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近年, 脳死の判定基準が議論されている。脳シンチグラム, とくにダイナミックスタディによる脳死の判定はすでに報告されている。また, ^{123}I -IMP および ^{99m}Tc -HMPAO等のアミンを用いた脳シンチグラムは脳が描出されないという特異な所見により, 脳死の診断に有用な情報を提供することが知られている。しかしながら, ^{99m}Tc -HMPAOの静脈注射時に同時に行われるダイナミックシンチグラムは著者らの知る限り報告がなく, 古典的な脳死の所見である“HOT NOSE SIGN”を呈することにより脳死の判定に附加的情報を提供した。われわれは ^{99m}Tc -HMPAO静注時に施行されたダイナミックシンチグラムによって“HOT NOSE SIGN”を呈し, 引き続いて行われたSPECTによって脳の描出を見なかった脳死の一例を報告し, その静注時のダイナミックシンチグラムの意義について議論した。