

# Tc-99m-HMPAO Regional Cerebral Blood Flow SPECT in Cerebral Rete Mirabile\*

Young Ha Park, M.D., Soo Kyo Chung, M.D., Sung Yong Lee, M.D.  
Kyung Sub Shinn, M.D., Jong Woo Kim M.D. and Yong Whee Bahk, M.D.

*Department of Radiology, Catholic University Medical College, Seoul, Korea*

＝ 국문초록 ＝

## Cerebral Rete Mirabile의 Tc-99m-HMPAO 국소뇌혈류 SPECT소견

가톨릭대학 의학부 방사선과학교실

박 영 하·정 수 교·이 성 용  
신 경 섭·김 종 우·박 용 휘

Cerebral rete mirabile는 잘 알려진 뇌혈관 질환으로 뇌혈관촬영상 내경동맥이 심한 협착 혹은 폐색, 뇌저부의 이상혈관망 형성 및 다수의 연수막동맥간문합과 경경수막 외내경동맥간문합의 특징적 소견을 나타낸다.

최근 방사성의약품의 발전과 함께, Tc-99m-HMPAO를 이용한 뇌SPECT는 뇌혈류역학의 평가, 병소의 조기발견 및 병소의 정확한 위치를 알기위한 상용진단 방법이 되었다.

저자들은 뇌혈관촬영으로 확진된 10명의 Cerebral rete mirabile 환자에서 뇌전산화단층촬영과 Tc-99m-HMPAO를 이용한 국소뇌혈류 SPECT를 검토하였다. 대상환자중 남자는 3명, 여자는 7명이었으며, 연령분포는 6세에서 38세이었다.

1) Tc-99m-HMPAO를 이용한 국소 뇌혈류 SPECT는 뇌의 경색부위 뿐만 아니라 허혈부위까지 나타냈으며, cerebral rete mirabile에서의 뇌의 침습된 부위를 나타내는데 있어서 뇌전산화단층촬영보다 우월하였다. 또한 모든 예에서 뇌전산화단층촬영보다 더 넓은 허혈부위를 보여주었다.

2) 다른 허혈성 뇌혈관질환과 비교하여 cerebral rete mirabile는 비균질성 방사능을 나타냈고, 이는 측부순환로에 의한 것으로 추측된다.

3) Tc-99m-HMPAO를 이용한 국소뇌혈류 SPECT는 뇌의 허혈부위의 범위를 평가, 문합수술의 계획 및 cerebral rete mirabile의 경과를 추적하는데 유용한 검사이다.

### Introduction

Cerebral rete mirabile (CRM) first reported by Takeuchi and Shimizu (1957), is a cerebrovascular disorder that manifests as occlusive lesion in carotid arteries of both hemispheres and development of an abnormal vascular network<sup>1-4</sup>.

Therefore the measurement of regional cerebral blood flow (rCBF) plays an important role for the assessment of cerebral hemodynamics<sup>5,6</sup>.

Computerized tomographic (CT) findings of CRM have been described in detail, but not all ischemic areas of the brain are revealed.

Recently technetium-99m-hexamethylpropylenamine oxime (Tc-99m-HMPAO) has been introduced for measurement of rCBF. This agent penetrates the blood brain barrier without

\*The study was supported by the research fund (1988) of Catholic Medical Center.

redistribution<sup>7-10</sup>.

We reported our experience of the use of Tc-99m-HMPAO rCBF SPECT in CRM. The aims of our research were (1) to study cerebral arterial perfusion changes and (2) to correlate perfusion changes and CT findings. We also evaluated the effect of anastomotic surgery in CRM patient with follow-up Tc-99m-HMPAO rCBF SPECT.

### Materials and Method

Ten patients with CRM confirmed by cerebral angiogram were evaluated by Tc-99m-HMPAO rCBF SPECT and brain CT.

Four of them were examined before and after external and internal carotid bypass surgery. There were 3 men and 7 women with age ranging from 6 to 38 years. SPECT imaging was carried out with a conventional rotating gamma camera and a dedicated computer system within 30 minutes of intravenous injection of 20 mCi of Tc-99m-HMPAO. Side-to-side difference in brain radioactivity was studied by profile analysis of regions of interest.

### Results

Clinical data of these 10 patients are summarized in Table 1. Clinical symptoms were mainly headache and motor disturbance such as hemiparesis. All patients showed characteristic angiographic findings of CRM (Fig. 1). The most frequent finding was occlusion of the internal carotid artery at the level of the supraclinoid portion.

In one patient with headache and vomiting, brain CT was negative both before and after contrast enhancement (Fig. 1). In the remaining 9 patients, some abnormalities were found on brain CT. The cardinal findings on brain CT were irregular lucent foci, ventricular dilatation and cortical atrophy (Fig. 2).

In all patients, Tc-99m-HMPAO rCBF SPECT

Table 1. Summary of 10 Patients with Cerebral Rete Mirabile

Case	Age/ Sex	Clinical Manifestations
1	24/F	Left hemiparesis for 5 days.
2	18/F	Intermittent headache for 12 days.
3	38/F	Frontal headache, vomiting for 3 days.
4	7/M	Left hemiparesis for 6 years.
5	20/F	Headache and vomiting for 1 years.
6	31/F	Left hemiparesis for 4 days.
7	6/M	Right hemiparesis for 4 days.
8	16/F	Right hemiparesis and dysphasia for 6 years.
9	18/F	Headache and dysphasia for 5 days.
10	38/M	Headache and dysphasia for 1 day.

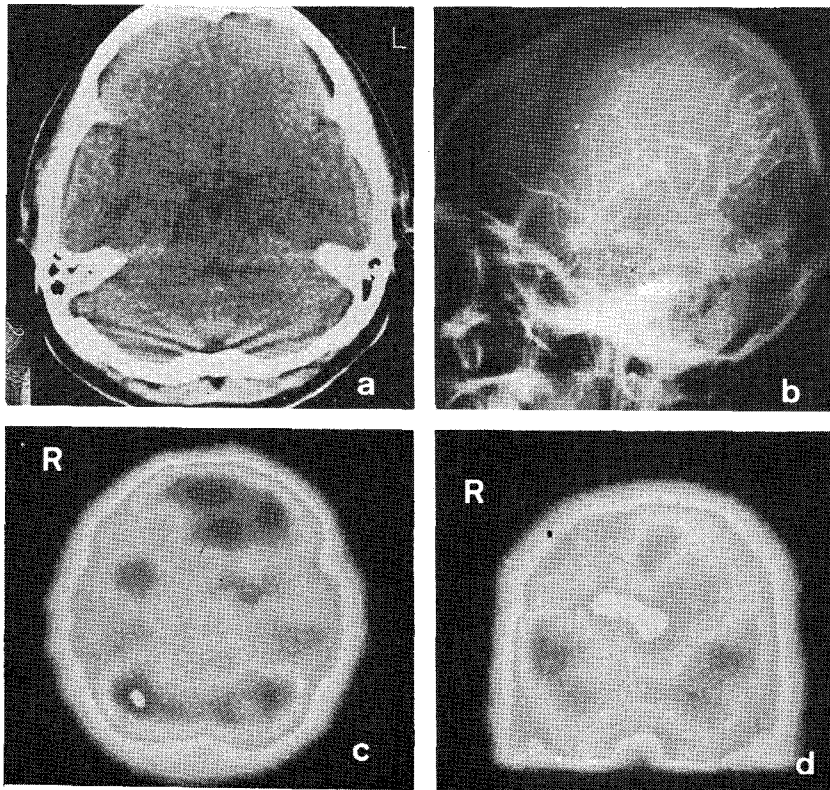
showed decreased rCBF in the lesional area which was much larger than that of brain CT (Fig. 2 and 3). Five patients (50%) exhibited inhomogeneous decrease in rCBF in the lesional area on Tc-99m-HMPAO rCBF SPECT (Fig. 3 and 4). In 3 patients Tc-99m-HMPAO rCBF SPECT demonstrated definite ischemic area which was missed by brain CT. After bypass surgery, Tc-99m-HMPAO rCBF SPECT showed increase in rCBF (Fig. 3 and 4).

### Discussion

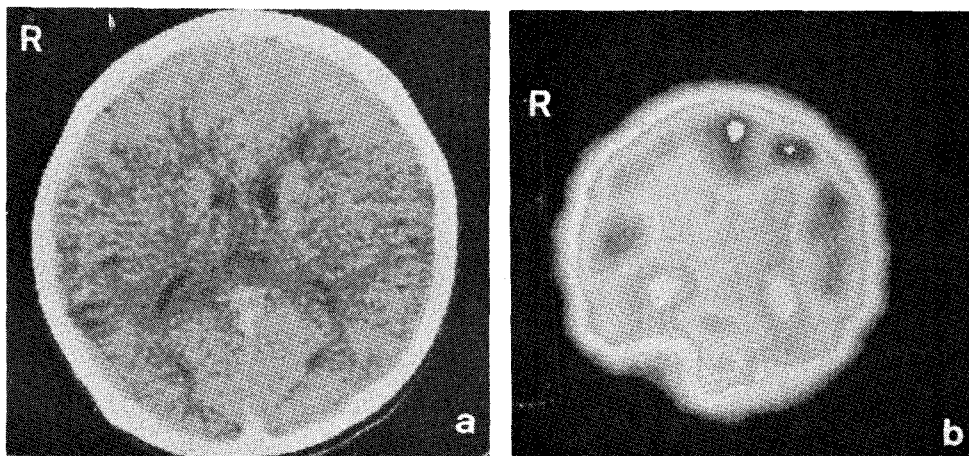
CRM is a well-known cerebrovascular occlusive disorder of unknown etiology. Incidence is high in childhood and adolescence. Bilateral involvement is a characteristic phenomenon of childhood CRM, whereas adult CRM is usually unilateral<sup>3,4</sup>.

Brain CT, MRI and rCBF SPECT have been used but the definitive diagnosis of CRM depends primarily on the cerebral angiography<sup>4</sup>.

The typical angiographic findings consist of marked stenosis or occlusion of the internal carotid artery, abnormal vasculature networks at the base of the brain and multiple leptomeningeal and transdural external and internal carotid anastomoses<sup>1,2,4</sup>.



**Fig. 1.** Brain CT after enhancement showing no abnormality (a). Right common carotid angiogram showing nearly complete obstruction at the level of supraclinoid portion of right ICA with abnormal vascular networks at the base of the brain, multiple leptomeningeal anastomoses fed by PCA and dilatation of ECA (b). Tc-99m-HMPAO brain SPECT showing homogeneously decreased uptake in right parietotemporal area (c & d).



**Fig. 2.** Postinfusion brain CT showing an irregular low density area in left frontal lobe with mild dilatation of ventricle (a). Tc-99m-HMPAO brain SPECT showing homogeneous perfusion defect involving right parietal and left parietooccipital lobe (b).

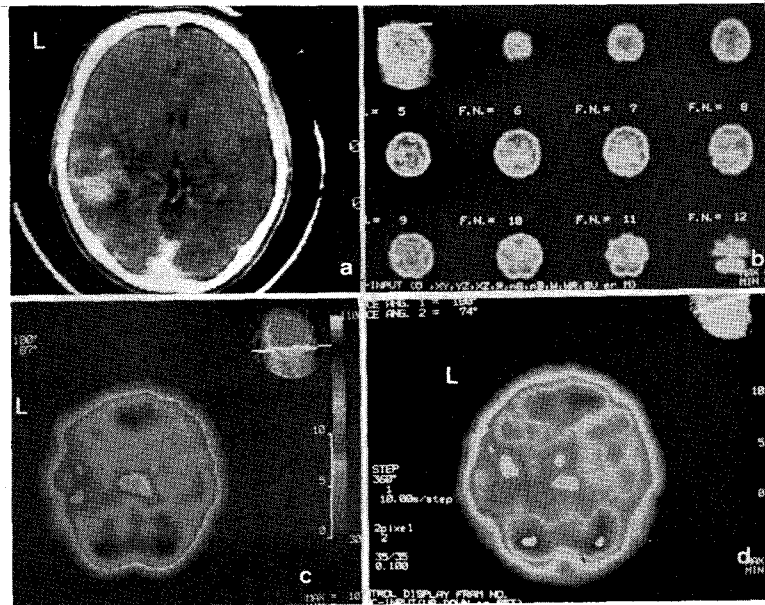


Fig. 3. Brain CT showing a large intracerebral hematoma in left temporal lobe (a), Tc-99m-HMPAO brain SPECT showing inhomogeneous perfusion defect involving parietotemporal lobe (b & c). Follow-up Tc-99m-HMPAO brain SPECT after bypass surgery showing slight improvement of perfusion (d).

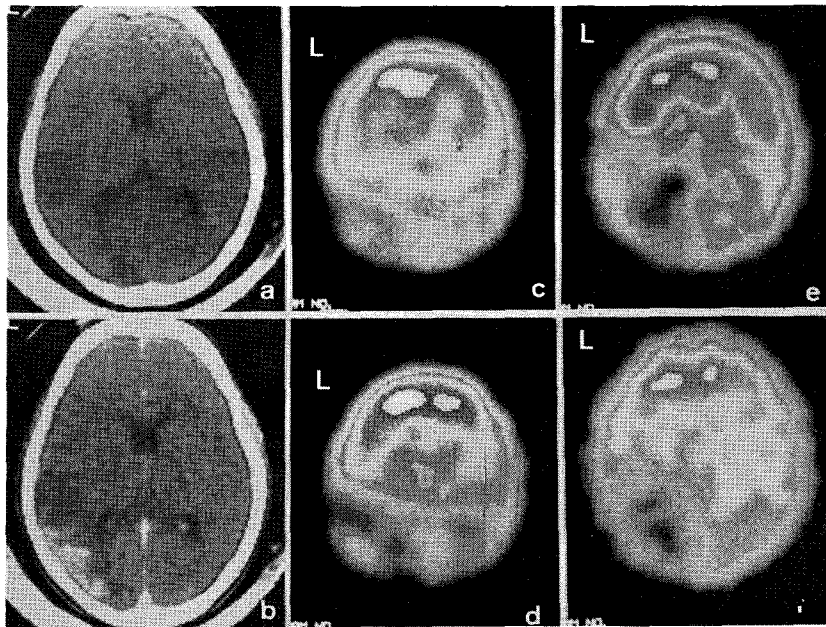


Fig. 4. Brain CT before and after enhancement showing a large low density area with marked enhancement in left occipital lobe, but normal finding on right (a & b). Preoperative Tc-99m-HMPAO brain SPECT showing inhomogeneous perfusion defect in left parietooccipital lobe and homogeneous perfusion defect in right occipital lobe (c & d). Follow-up brain SPECT after right side bypass surgery showing moderate improvement of perfusion in right occipital lobe (e & f).

Brain CT of CRM may show characteristic changes including 1) cortical atrophy, often most severe in the frontal lobe, 2) ventricular dilatation, 3) irregular bilateral and multiple low density foci in the cortex and subcortical white matter, 4) occasional contrast enhancement and 5) intracranial hemorrhage<sup>2,3)</sup>.

CT does not reveal functional change or arterial perfusion of the brain. Tc-99m-HMPAO rCBF SPECT revealed not only the infarcted area but also the ischemic area in the brain and proved to be superior to brain CT in demonstrating the affected area in the brain and proved to be superior to brain CT in demonstrating the affected area of CRM<sup>11,12)</sup>. All cases showed much larger ischemic area in Tc-99m-HMPAO rCBF SPECT than in CT. As compared with other ischemic cerebrovascular disorders, CRM showed inhomogeneous activity due probably to collaterals. Tc-99m-HMPAO rCBF SPECT is useful to evaluate the extent of ischemic area of the brain, to plan the anastomotic surgery and to follow-up the course of CRM.

## REFERENCES

- 1) 이영근, 최창락, 송진언 : *Cerebral rete mirabile*의 임상관찰과 뇌혈관조영상의 검토. *대한신경외과학회지* 4:51-59, 1975
- 2) 고영태, 이중석, 서수지, 김순용 : *Cerebrovascular moyamoya disease*의 전산화단층촬영. *대한방사선의학회지* 16:327-335, 1980
- 3) Handa J, Nakano Y, et al: *Computerized tomography*

- in moyamoya syndrome. Surg Neurol* 7:315-319, 1977
- 4) Satoh S, Shibuya H, et al: *Analysis of the angiographic findings in cases of childhood moyamoya disease. Neuroradiology* 30:111-119, 1988
- 5) Takeuchi S, Tanaka R, et al: *Cerebral hemodynamics in patients with moyamoya disease: A study of regional cerebral blood flow by the Xe-133 inhalation method. Surg Neurol* 23:468-474, 1985
- 6) Kuwabara Y: *Evaluation of regional cerebral circulation and metabolism in moyamoya disease using positron emission computed tomography. 核醫學* 23: 1381-1402, 1986
- 7) Ell PJ, Hocknell JML, et al: *A Tc-99m-labelled radiotracer for the investigation of cerebral vascular disease. Nuclear Medicine Communications*, 6:437-441, 1985
- 8) Holmes RA, Chaplin SB, et al: *Cerebral uptake and retention of Tc-99m-hexamethylpropyleneamine oxime. Nuclear Medicine Communications* 6:443-447, 1985
- 9) Nowotnik DP, Canning LR, et al: *Development of a Tc-99m-labelled radiopharmaceutical for cerebral blood flow imaging. Nuclear Medicine Communications* 6:499-506, 1985
- 10) Sharp PF, Smith FW, et al: *Technetium-99m HMPAO stereoisomers as potential agents for imaging regional cerebral blood flow: Human volunteer studies. J Nucl Med* 27:171-177, 1986
- 11) Abdel-Dayem HM, Sadek SA, et al: *Changes in cerebral perfusion after acute head injury: Comparison of CT with Tc-99m HMPAO SPECT. Radiology* 165:221-226, 1987
- 12) Podreka I, Suess E, et al: *Initial experience with Technetium-99m HMPAO brain SPECT. J Nucl Med* 28:1657-1666, 1987