Annals of Nuclear Medicine Vol. 16, No. 7, 495–498, 2002

# Extraosseous accumulation of $^{99m}$Tc phosphonate complexes in primary brain tumor evaluated with SPECT

Aya SUZUKI,** Takashi TOGAWA,* Junpei KUYAMA,* Tadaki NAKAHARA,* Nobuharu YUI,* Toshihiko IUCHI,*** Masaru OGA*** and Katsunobu OSATO***

*Division of Nuclear Medicine, Chiba Cancer Center
**Oral Surgery, Department of Oral Restitution, Division of Oral Health Sciences, Graduate School, Tokyo Medical and Dental University
***Division of Neurological Surgery, Chiba Cancer Center

Although extraosseous accumulations of $^{99m}$Tc phosphate complexes are phenomena which can often be seen, no case showing extraosseous accumulation to brain tumor on SPECT has been reported. We report here two cases of primary brain tumor showing extraosseous accumulation of $^{99m}$Tc phosphate in bone SPECT. $^{201}$Tl SPECT also showed increased $^{201}$Tl uptake by the tumor. Comparing bone SPECT with $^{201}$Tl SPECT, the regions of abnormality of both SPECTs were very similar in the case of glioblastoma, but in the case of malignant lymphoma the region showing intense uptake of $^{99m}$Tc-MDP was smaller than that on $^{201}$Tl SPECT. It was revealed that bone SPECT is more useful in the assessment of extraosseous accumulation to a primary brain tumor than conventional bone scintigraphy.

**Key words:** extraosseous accumulation, bone SPECT, primary brain tumor

## INTRODUCTION

IN VARIOUS KIND OF TUMORS, extraosseous accumulations on bone scintigraphy have ever been reported. They can be seen in primary malignant tumors, such as breast tumor,[1] neuroblastoma, bile duct tumor,[2] and malignant fibrous histiocytoma.[3] Although there are reports of extraosseous uptake in primary brain tumors with $^{99m}$Tc bone scintigrapy,[4] to the best of our knowledge no case has been reported in which Single Photon Emission CT (SPECT) was used. We report on two cases of primary brain tumor which showed extraosseous accumulation evaluated with SPECT.

## CASE REPORTS

*Case 1.* A 54-year-old man had paralysis and paresthesia of the left upper limb. CE-MRI revealed two enhanced tumors and the tumor of the parietal lobe had central necrosis (Fig. 1). A preoperative whole body bone scan was taken 3 hours after the intravenous injection of 740 MBq $^{99m}$Tc- Hydroxy Methylene Diphosphonate (HMDP) and revealed a mild uptake in the right skull (Fig. 2a). Furthermore, bone SPECT was taken with a triple head rotating gamma camera (GCA9300DI). In SPECT, there were two mild accumulations corresponding to brain tumors shown in an MRI study in the right frontal and parietal lobes (Fig. 2b). $^{201}$Tl SPECT was also taken 15 min after the intravenous injection of 111 MBq of $^{201}$Tl chloride and it delineated two brain tumors with intense uptake (Fig. 3). The patient underwent extraction of the tumor and was diagnosed pathologically to have glioblastoma with hypervascularity and necrosis.

*Case 2.* A 72-year-old woman presented with palsy of the right upper limb. CE-MRI revealed an enhanced mass with peritumoral edema in the left brain (Fig. 4). $^{99m}$Tc bone scintigraphy showed no abnormality (Fig. 5a). In contrast, SPECT showed intense uptake by the left frontal lobe tumor and the region of the uptake was smaller than that of abnormal $^{201}$Tl accumulation on $^{201}$Tl

Received June 25, 2002, revision accepted August 5, 2002.
For reprint contact: Aya Suzuki, D.D.S., Division of Nuclear Medicine, Chiba Cancer Center, 666–2, Nitona-cho, Chuo-ku, Chiba 260–8717, JAPAN.
E-mail:asuzuki@internet.chiba-cc.pref.chiba.jp

SPECT (Fig. 5b, 6). Whole body $^{67}$Ga SPECT[5] was also performed and it indicated increased tracer uptake by the left brain tumor (Fig. 7). She was diagnosed to have malignant lymphoma by biopsy and underwent further chemotherapy.

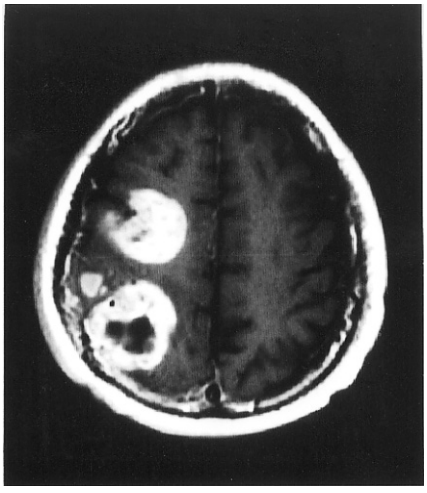

**Fig. 1** CE-MRI showed the brain tumors and the tumor in parietal lobe had necrosis.

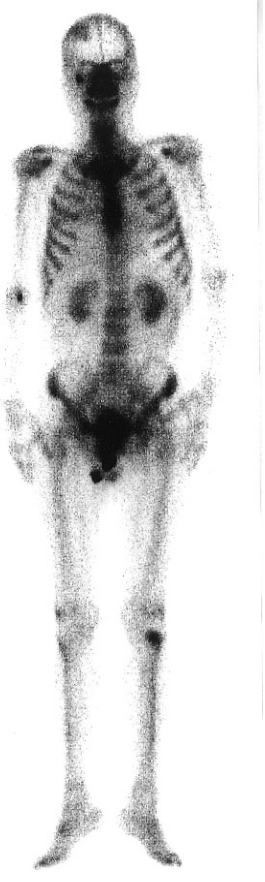

**Fig. 2a** $^{99m}$Tc bone scintigraphy revealed mild uptake in right skull.

**Fig. 2b** In bone SPECT, there were two accumulations in right frontal and parietal lobes, with decreased uptake inside and increased uptake outside.

**Fig. 3** $^{201}$Tl also intensely accumulated to the tumor where $^{99m}$Tc bone SPECT showed extraosseous uptake.

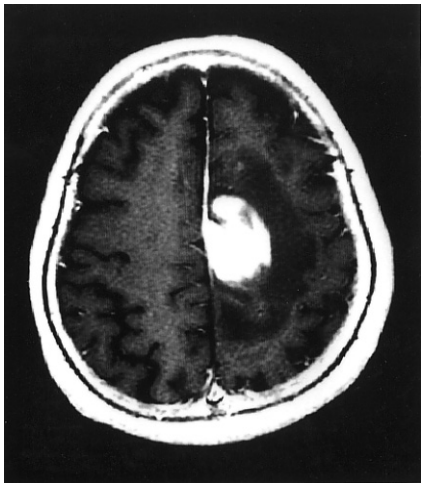

**Fig. 4** In CE-MRI, the left frontal lobe tumor with strong enhancement and peri-tumoral edema was shown.

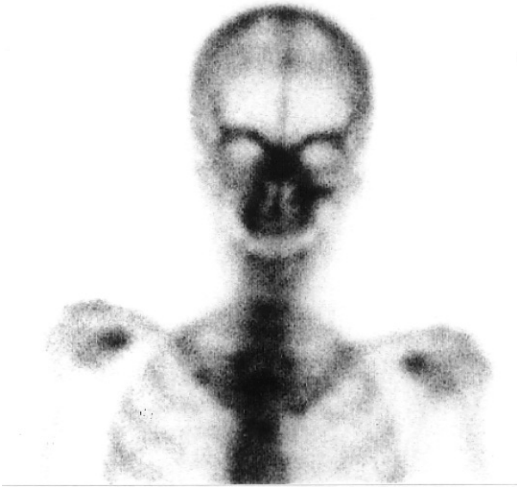

**Fig. 5a** $^{99m}$Tc bone scintigraphy showed no abnormality.

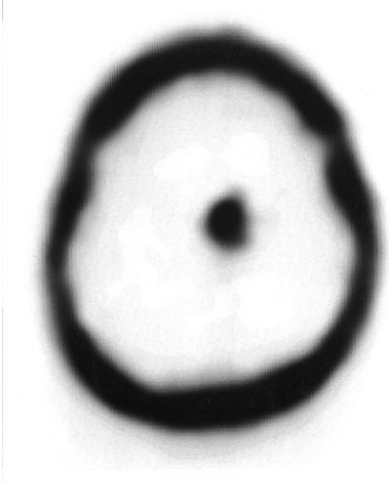

**Fig. 5b** Bone SPECT revealed intense uptake of tracer in left frontal lobe.

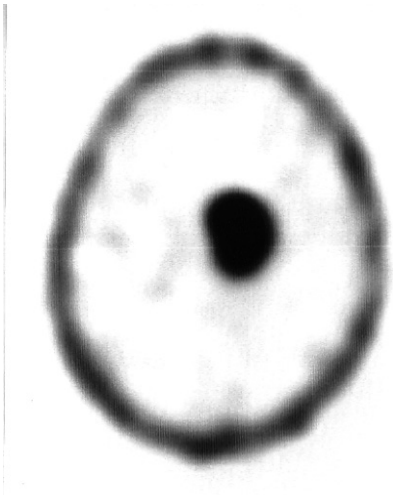

**Fig. 6** $^{201}$Tl accumulated intensely to the tumor corresponding to the tumor shown in CE-MRI.

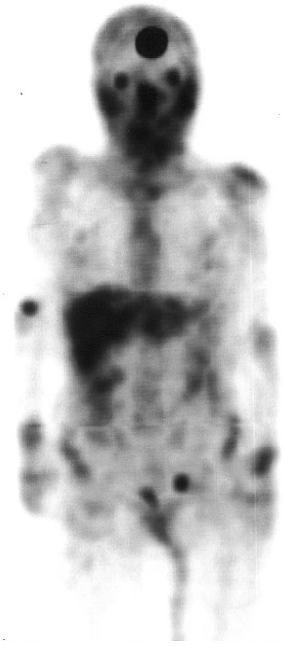

**Fig. 7** Whole body $^{67}$Ga SPECT showed intense accumulation in left brain tumor.

## DISCUSSION

Extraosseous accumulations of $^{99m}$Tc phosphate complexes are phenomena which can often be seen. They can be seen in primary malignant tumors such as pulmonary tumor, neuroblastoma, metastatic malignant tumor such as hepatic metastasis, benign tumor such as myoma of the uterus, meningioma, cerebral infarction, myocardial infarction, imflamation, and ectopic calcinosis.[6] Yasuda et al.[2] demonstrated that among 509 bone scintigraphies they found 43 cases of extraosseous uptake and 2 of 43 were of extraosseous uptake in primary malignant tumors. But no case of extraosseous uptake in primary brain tumors was seen. In our division, we saw 29 cases of extraosseous uptake among 2,607 cases from April, 2001 to March, 2002 and 2 of 29 were of extraosseous uptake in primary brain tumors. Bone scintigraphy was perfomed to detect skeletal metastasis because these two patients were suspected of having metastatic brain tumor at the beginning, and it was revealed that the brain tumor showed signs of extraosseous accumulation. Comparing bone SPECTs with $^{201}$Tl SPECTs, the regions of abnormality of both SPECTs are very similar in the case of glioblastoma, but in case of malignant lymphoma the region showing intense uptake of $^{99m}$Tc Methylene Diphosphonate (MDP) was smaller than that of $^{201}$Tl SPECTs. There have been a variety of explanations of the mechanism of extraosseous uptake in non-calcifying lesions: increased vascularity, capillary permeability, cellular abnormality in calcium

metabolism, abnormality in binding of $^{99m}$Tc phosphate complexes to phosphate enzymes, and binding of $^{99m}$Tc phosphate to immature collagen were reported as major mechanism.[3,7–9] Concerning increased vascularity, Chaudhuri et al. denied that uptake can be invoked for hypervascularity.[1] Zucker et al. indicated that accumulation of $^{99m}$Tc phosphate complex at first occurred in the margin of infarction with blood flow. This fact suggests a correlation between uptake of $^{99m}$Tc phosphate complex and blood flow around the necrotic lesion.[10] In contrast, Siegel et al. demonstrated that tissue with a decrease in blood flow is accompanied by an increase in the uptake of $^{99m}$Tc diphosphonate (EHDP) through another route.[11] From the viewpoint of pathological findings in the two cases, necrosis and increased vascularity can be seen in the case of glioblastoma, and in the case of malignant lymphoma hypervascularity was demonstrated. These facts suggests a correlation between the uptake of $^{99m}$Tc phosphate complex and hypervascularity and accumulation to the margin of the necrosis. In conclusion, it was demonstrated from these two cases that bone SPECT more readily enabled accurate assessment of extraosseous accumulation to the primary brain tumor than the conventional bone scintigraphy.

## REFERENCES


1. Chaudhuri TK, Chaudhuri TK, Gulesserian HP, Christie JH, Tonami N. Extraosseous noncalcified soft-tisse uptake of $^{99m}$Tc-polyphosphate. *J Nucl Med* 1974; 15 (11): 1054–1056.
2. Yasuda E, Yoshida H, Ichikawa H, Matsuo S, Kimura T, Kanamori I, et al. Extraosseous accumulation of $^{99m}$Tc-MDP—with special reference to intratumor accumulation. (in Japanese) *Rinsho Hoshasen* 1983; 28 (8): 851–857.
3. Rosenthall L. $^{99m}$Tc-methylene diphosphonate concentration in soft tissue malignant fibrous histiocytoma. *Clin Nucl Med* 1978; 3 (2): 58–61.
4. Grames GM, Jansen C, Carlsen EN, Davidson TR. The abnormal bone scan in intracranial lesions. *Radiography* 1975; 115 (1): 129–134.
5. Togawa T, Yui N, Kinoshita F, Ichihara Y, Hiyoshi K, Fujigasaki K, et al. Clinical application of whole body $^{67}$Ga SPECT (WB SPECT) as a new tumor imaging method. (in Japanese) *Rinsho Hoshasen* 2000; 45 (9): 1079–1087.
6. Togawa T, Hoshi K, Kimura K, Sato T, Matsuda S, Uchida T, et al. A case of adult T-cell leukemia with metastatic calcification. *Eur J Nucl Med* 1985; 10 (1–2): 90–92.
7. Charkes ND. Mechanisms of skeletal tracer uptake. *J Nucl Med* 1979; 20 (7): 794–795.
8. Rengachary SS, Batnitzky S, Arjunan K. Diagnosis of intracranial meningioma with radionuclide bone scan. *Surg Neurol* 1980; 14 (5): 337–341.
9. Ozarda AT, Legaspi JR, Haynie TP. Detection of a brain metastasis from osteosarcoma with $^{99m}$Tc-methylene diphosphonate bone scanning. *Eur J Nucl Med* 1983; 8 (12): 552–554.
10. Zucker I, Charkes ND, Seidmen EJ, Maurer AH. Soft-tissue uptake of technetium-99m-MDP after prostate cryoablation. *J Nucl Med* 1997; 38 (4): 525–528.
11. Siegel BA, Donovan RL, Aiderson PO, Mack GR. Skeletal uptake of $^{99m}$Tc-diphosphonate in relation to local bone blood flow. *Radiology* 1976; 120 (1): 121–123.