

## Relatively high F-18 fluorodeoxyglucose uptake in paranasal sinus aspergillosis: A PET study

Joji KAWABE,\* Terue OKAMURA,\*\* Koichi KOYAMA,\*\* Miyuki SHAKUDO,\*\* Hirokazu SAKAMOTO,\*\*\* Toshiko KOBASHI,\*\* Wang Li JUAN,\* Makoto SHIGEMATSU,\* Ryusaku YAMADA\*\* and Hironobu OCHI\*

*\*Division of Nuclear Medicine, \*\*Department of Radiology, and \*\*\*Department of Otorhinolaryngology, Osaka City University Medical School*

We report a case of maxillary sinus (MS) aspergillosis studied by positron emission tomography (PET) with F-18 fluorodeoxyglucose (FDG) and by <sup>67</sup>Ga-citrate (Ga) single photon emission computed tomography (SPECT). The FDG uptake existed in the lesion and along the inflammatory edematous mucous membrane of the MS. Ga uptake occurred not only in the lesion and in the mucous membrane but also in the MS. Relative quantification, the standardized uptake value (SUV) of the lesion showed relatively high FDG uptake (3.7). But in other reports, many malignant head and neck tumors had a SUV below 3.7. It was thought to be difficult to differentiate between aspergillosis and malignant head and neck tumors by FDG-PET.

**Key words:** invasive aspergillosis, maxillary sinus, fluorodeoxyglucose (FDG), positron emission tomography (PET), <sup>67</sup>Ga-citrate (Ga) single photon emission computed tomography (SPECT)

### INTRODUCTION

ASPERGILLOSIS of the paranasal sinuses is caused by a spore-forming fungus which is usually found in the soil and air.<sup>1</sup> The paranasal sinus is not a common site for aspergillosis and several reports have described this fungal disease.<sup>2</sup> But, to our knowledge, this is the first report of aspergillosis of the paranasal sinus investigated by positron emission tomography (PET) with F-18-fluoro-2-deoxy-D-glucose (FDG). FDG has been used in clinical PET to differentiate between benign and malignant lesions.<sup>3-6</sup> In this case, invasive aspergillosis of the sinus showed a relatively high uptake of FDG.

### CASE REPORT

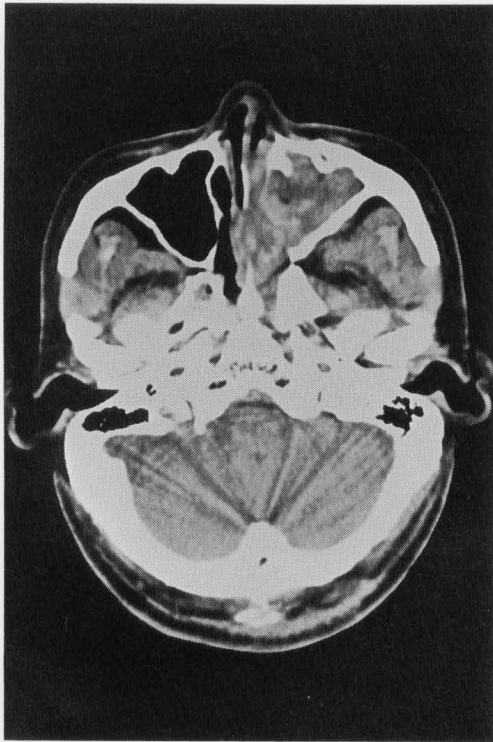
A 65-year-old man presented with a 2-month history of

progressive left nasal obstruction and left rhinorrhea. Clinical examination showed polyps in the left nasal cavity. Computed tomography (CT) demonstrated a non-homogeneous soft tissue density in the left maxillary sinus extending into the left nasal cavity and epipharynx, together with bone destruction of the medial wall of the left maxillary sinus. A relatively high density area was noted inside the left maxillary sinus (Fig. 1). Single photon emission computed tomography (SPECT) with <sup>67</sup>Ga-citrate (Ga) showed an abnormally high uptake to the posterior and left-posterior part of the physiological accumulation in the nasal cavity and a diffuse abnormally low uptake in the left maxillary sinus (Fig. 2). The former abnormal uptake corresponded to the high density area and the latter corresponded to the soft tissue density in the left maxillary sinus in the CT scan image. Subsequently, FDG-PET was performed to further examine the nasal/paranasal sinus region. FDG was produced with the NKK-Oxford superconducting cyclotron and NKK synthesis system. A HEADTOME IV SET-1400W-10 (Shimadzu Corp., Japan) was employed for the PET study. It has 4 detector rings providing 7 contiguous slices at 11 mm intervals. The effective spatial resolution used in the study was 14 mm in FWHM. The transmission scan was

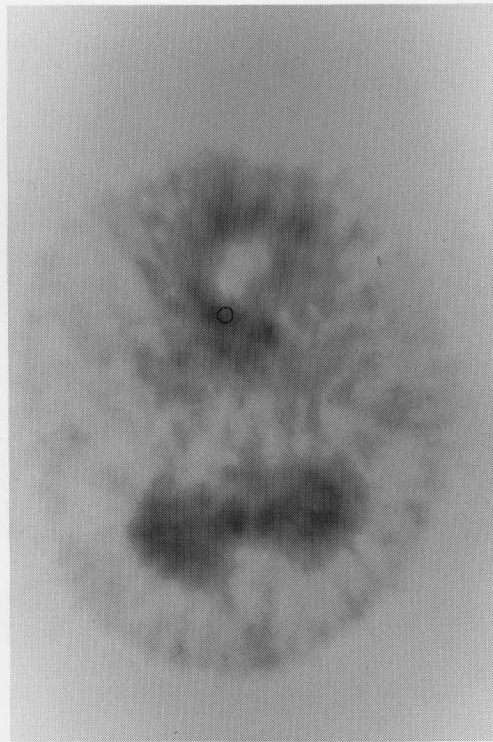
Received August 20, 1997, revision accepted February 19, 1998.

For reprint contact: Joji Kawabe, M.D., Division of Nuclear Medicine, Osaka City University, 1-5-7 Asahimachi, Abeno-ku, Osaka 545-8586, JAPAN.

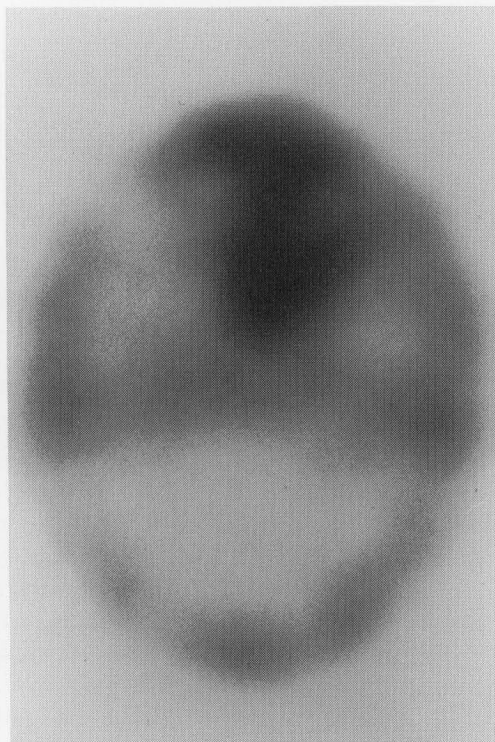
E-mail: kawabe@msic.med.osaka-cu.ac.jp



**Fig. 1** Plain CT showing bone destruction and an area with a relatively high density.



**Fig. 3** FDG-PET image showing an annular-shaped FDG uptake was noted in the periphery of the left maxillary sinus, with a relatively higher FDG uptake extending from the interior of the sinus to the nasal cavity.



**Fig. 2** Ga-SPECT showing abnormal high uptake to the posterior and left-posterior part of the physiological accumulation in the nasal cavity and diffuse abnormal low uptake in the left maxillary sinus.

performed with a  $^{68}\text{Ge}/^{68}\text{Ga}$  ring source for attenuation correction. Images were obtained from 40 to 55 minutes after intravenous injection of 370 MBq FDG in the fasting condition. As shown in Fig. 3, an annular-shaped FDG uptake was noted in the periphery of the left maxillary sinus, with a relatively higher FDG uptake extending from the interior of the sinus to the nasal cavity. A circular region of interest (ROI) 6 mm in diameter was drawn in the higher uptake area. And quantitative analysis of the mean activity in the ROI was performed by computing the standardized uptake value (SUV) with the following formula:

$$\text{SUV} = \frac{\text{mean ROI activity (MBq/ml)}}{\text{injected dose (MBq/kg body weight)}}$$

The calculated SUV in this area was 3.7.

Open biopsy of the left maxillary sinus was performed the next day. Examination showed an edematous mucous membrane with retention of yellowish pus indicating an inflammatory process. No tumor or other growth was present. We also noted the complete disappearance of the laterosuperior portion of the nasal bone in the interior wall and the concha nasalis media, as well as the presence of numerous black sludge-like masses covering the area extending from the interior wall of the left maxillary sinus to the nasal cavity. Histopathological examination of the

black masses showed a large number of fungus balls, identified as aspergilli. In addition, accumulation of inflammatory cells such as lymphocytes was also noted. A diagnosis of aspergilloma with paranasal sinusitis was confirmed. Removal of the black masses was removed followed by maxillary sinus and nasal cavity washing and drainage, with normal saline and anti-fungal drugs. The procedure was repeated daily for seven days, and the patient was discharged with no pain or nasal discharge.

## DISCUSSION

Aspergillosis of the nose and paranasal sinuses is not common but more cases have been recognized in recent years.<sup>7</sup> Aspergillomycosis of the sinuses is of four pathological types: non-invasive, invasive, fulminant and allergic type.<sup>12</sup> Based on the clinical presentation, this patient had invasive aspergillosis of the nose and paranasal sinuses. The diagnosis was based on the presence of large quantities of black sludge-like masses covering an extensive area of the nasal cavity and extending from the medial wall of the maxillary sinus to the nasal cavity.

As for the image diagnoses, the CT image showed marked bone destruction, and nonhomogeneous soft tissue density in the left maxillary sinus; and relatively high density was noted inside the left maxillary sinus. The bone destruction was a finding that strongly indicated malignancy. A diagnosis of aspergillosis on the CT images, however, was made based on the presence of the relatively high density.<sup>8</sup>

On the Ga-SPECT image, two abnormal uptakes were shown. The abnormally high uptake to the posterior and left-posterior part of the physiological accumulation in the nasal cavity also suggested the possible presence of malignancy. The other abnormal uptake in the left maxillary sinus corresponded to the inflammation in the left maxillary sinus in comparison with CT and open biopsy findings. PET study showed two FDG uptakes which were a relatively higher FDG uptake extending from the interior of the sinus to the nasal cavity and an annular-shaped FDG uptake in the periphery of the left maxillary sinus. In comparison with Ga-SPECT images, the relatively higher FDG uptake extending from the interior of the sinus to the nasal cavity corresponded to the abnormally high uptake in the posterior and left-posterior part of the physiological accumulation in the nasal cavity. The extent of the uptake of the lesion on Ga-SPECT was greater than that on FDG-PET. On the other hand, as for the left maxillary sinus, there was a important difference between FDG-PET and Ga-SPECT images. The FDG uptake existed along the edematous mucous membrane of the maxillary sinus but the abnormally slight uptake on the Ga-SPECT image existed in the maxillary sinus. In a report of liver abscess with Ga-SPECT, Sanger et al. indicated Ga filling in the liver abscess and that gram-stain of the aspirate from the liver abscess demonstrated

neutrophils, but no microorganisms were seen or cultured.<sup>9</sup> Otherwise, in a report of macroautoradiography on FDG uptake in inflammatory tissue, a high uptake in the abscess wall and surrounding granulation tissue was shown. There was a weak positive correlation between cell density and the degree of FDG uptake.<sup>10</sup> And so FDG are thought not to exist in a lesion which has no blood flow. On the other hand, on the Ga-SPECT images, abnormal low uptake was seen in the maxillary sinus which had no vessel on the open biopsy findings, and the other factors apart from blood flow contributed to the uptake of Ga in the lesion.

In the relative quantitative analysis, the SUV of the aspergillosis lesion was 3.7, a value that is commonly seen in malignant tumors. For example, Reisser, et al.<sup>11</sup> reported that the SUVs of 48 malignant head and neck tumors ranged from 2.0 to 5.9 (the SUVs of 32 of the 48 malignant head and neck tumors were below 3.7). Laubenbacher, et al.<sup>12</sup> showed that the SUVs of 22 head and neck malignant tumors ranged from 2.0 to 13.8 (the SUVs of 8 of 22 cases were below 3.7). In our institution, the SUVs of 80 head and neck malignant tumors ranged from 2.59 to 20.89 (the SUVs of 7 of 80 cases were below 3.7). Accordingly, when the SUV of the lesion was 3.7, it was difficult to differentiate between the aspergillosis and the malignant tumors by means of SUV.

As for the aspergillosis of other portions, Patz et al.<sup>13</sup> indicated that the average SUV of pulmonary fungus nodules was less than 2.1. We think that the SUV in our patient was artificially high due to the inflammatory process in the sinus associated with aspergillomycosis. In general, the degree and type of inflammatory responses are important in determining FDG uptake.<sup>14</sup> Accordingly, one must be careful when evaluating the results of FDG-PET study in the presence of inflammation.

## REFERENCES

1. Sarti EJ, Blaugrund SM, Lin PT, Camins MB. Paranasal sinus disease with intracranial extension: aspergillosis versus malignancy. *Laryngoscope* 98: 632-635, 1988.
2. Shirouzu K, Hasuo K, Yasumori K, Mizushima A, Kuroiwa T, Masuda K, et al. MR imaging in paranasal and intracranial aspergillosis. *Nippon Acta Radiologica* 51: 768-774, 1991.
3. Lewis PJ, Salama A. Uptake of fluorine-18-fluorodeoxyglucose in sarcoidosis. *J Nucl Med* 35: 1647-1649, 1994.
4. Griffeth LK, Dehdashti F, McGuire AH, McGuire DJ, Perry DJ, Moerlein SM, et al. PET evaluation of soft-tissue masses with fluorine-18-fluoro-2-deoxy-D-glucose. *Radiology* 182: 185-194, 1992.
5. Strauss LG, Clorius JH, Schlag P, Lehner B, Kimmig B, Engenhart R, et al. Recurrence of colorectal tumors: PET evaluation. *Radiology* 179: 329-332, 1989.
6. Kubota K, Matsuzawa T, Fujiwara T, Ito M, Hatazawa J, Ishiwata K, et al. Differential diagnosis of lung tumor with

- positron emission tomography: a prospective study. *J Nucl Med* 31: 1927–1933, 1990.
7. Milroy CM, Blanshard JD, Lucas S, Michaels L. Aspergillosis of the nose and paranasal sinuses. *J Clin Pathol* 42: 123–127, 1989.
  8. Zinreich SJ, Kennedy DW, Malat J, Curtin HD, Epstein JI, Huff LC, et al. Fungal sinusitis: Diagnosis with CT and MR imaging. *Radiology* 169: 439–444, 1988.
  9. Sanger VK, Gini A, Fuentes R, Holmes R. Diagnosis of a Liver Abscess with Ga-67 and Radiocolloid Tomography. *Clin Nucl Med* 14: 443–445, 1989.
  10. Yamada S, Kubota K, Kubota R, Ido T, Tamahashi N. High Accumulation of Fluorine-18-Fluorodeoxyglucose in Turpentine-Induced Inflammatory Tissue. *J Nucl Med* 36: 1301–1306, 1995.
  11. Reisser CH, Haberkorn U, Strauss LG. The relevance of positron emission tomography for the diagnosis and treatment of head and neck tumors. *J Otolaryngol* 22: 231–238, 1993.
  12. Laubenbacher C, Saumweber D, Wagner-Manslau C, Kau RJ, Herz M, Avril N, et al. Comparison of Fluorine-18-Fluorodeoxyglucose PET, MRI and Endoscopy for Staging Head and Neck Squamous-Cell Carcinomas. *J Nucl Med* 36: 1747–1757, 1995.
  13. Patz EF, Lowe VJ, Hoffman JM, Paine SS, Burrowes P, Coleman RE, et al. Focal pulmonary abnormalities: evaluation with F-18 fluorodeoxyglucose PET scanning. *Radiology* 188: 487–490, 1993.
  14. Larson SM. Cancer or inflammation? A Holy Grail for Nuclear Medicine. *J Nucl Med* 35: 1653–1655, 1994.