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Thallium-201 accumulation in a patient with brain abscess

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A 57-year-old man was admitted to our hospital because of high fever and generalized tonic seizure. Brain magnetic resonance imaging (MRI) delineated multiple abnormal intensity areas. Thallium-201 (^{201}Tl) scintigraphy revealed abnormal uptake in the brain. The imaging findings did not allow definitive exclusion of brain tumor, even though brain abscess was the more strongly suspected diagnosis. As the patient improved, the multiple abnormal intensity areas in the brain on MRI and the abnormal areas of accumulation on ^{201}Tl scintigraphy were reduced, and eventually completely disappeared. A final diagnosis of brain abscess was therefore made. Since relatively few studies have reported ^{201}Tl accumulation in cases of brain abscess, we report here our patient in whom the changes in the accumulation of ^{201}Tl in a brain abscess were observed over time.

Key words: thallium-201 (^{201}Tl) scintigraphy; brain abscess, magnetic resonance imaging (MRI)

INTRODUCTION

THALLIUM (Tl) scintigraphy is widely employed for differentiating between benign and malignant tumors, and for assessing the effects of radiotherapy in brain tumor.[1,2]

Apart from uptake of the radionuclide by malignant brain tumors, Tl accumulation has also been noted in cerebral infarction, hematoma, meningioma and metastatic brain tumors.[3–5] Furthermore, Tl accumulation has been confirmed in inflammatory diseases, such as aspergillosis and candidiasis.[6,7] Relatively few studies have, however, reported ^{201}Tl accumulation in a brain abscess.[8–10]

We report here a patient in whom changes in the accumulation of ^{201}Tl in a brain abscess were observed over time.

CASE REPORT

The patient was a 57-year-old man who was admitted to the emergency department of our hospital on January 17, 2001. His chief complaints were fever and generalized tonic seizure. Laboratory findings at admission included a white blood cell (WBC) count of 14,100/μl and a serum C-reactive protein (CRP) level of 6.6 mg/d*l*. Brain computed tomography (CT) revealed a small low-density area in the right frontal lobe. Brain magnetic resonance imaging (MRI) was performed on January 20, 2001 (4 days after the onset of symptoms), and the T1-weighted images revealed spotty high-intensity areas, 2 to 3 mm in diameter, in the frontal lobe. In the T2-weighted images, these areas were observed as a mixture of high intensity and low intensity areas, with a poorly demarcated high intensity area suggestive of edema (Figs. 1a, b). Although these findings supported the diagnosis of an inflammatory disease, such as encephalitis or meningitis, the possibility of brain tumors (in particular, metastatic brain tumor), atypical cerebral infarction or multiple sclerosis could not be excluded. Further examination was therefore carried out for differential diagnosis. Brain MRI on January 29 (13 days after the onset of symptoms) revealed a slight expansion of the lesion in the frontal lobe (Fig. 2). ^{201}Tl single-photon emission computed tomography (SPECT) was performed on January 31 (15 days after the onset of symptoms). Fifteen minutes after intravenous injection of 111 MBq of ^{201}Tl chloride, SPECT was performed on axial, coronal and sagittal planes. These images revealed abnormal accumulation in the right frontal lobe and parietal lobe, and left frontal lobe, which was almost entirely consistent with the findings on MRI conducted two days earlier (Fig. 3). Based on the axial views of SPECT, regions of interest (ROIs) were established in the lesions and normal areas of the brain, to estimate the ratio of uptake by the lesion to that by the normal brain (L/N

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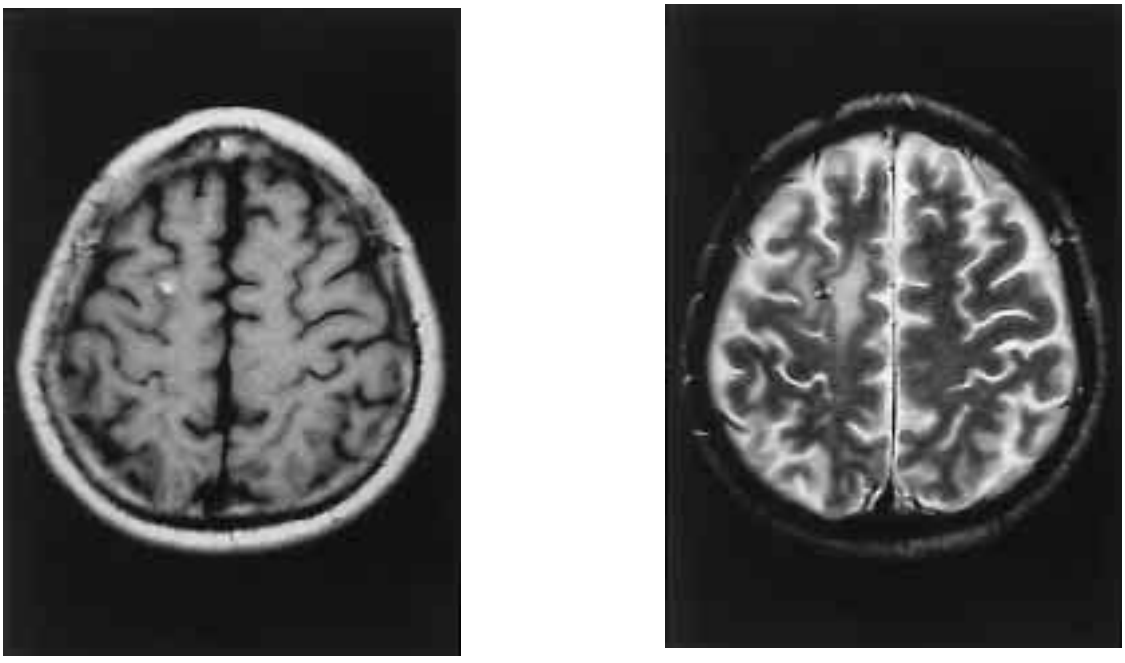

a **b**

Fig. 1 a: T1-weighted images revealed spotty high-intensity areas, 2 to 3 mm in diameter, in the right frontal lobe. b: In the T2-weighted images, these areas were observed as a mixture of high intensity and low intensity areas, with an ill-demarcated high intensity suggestive of edema.

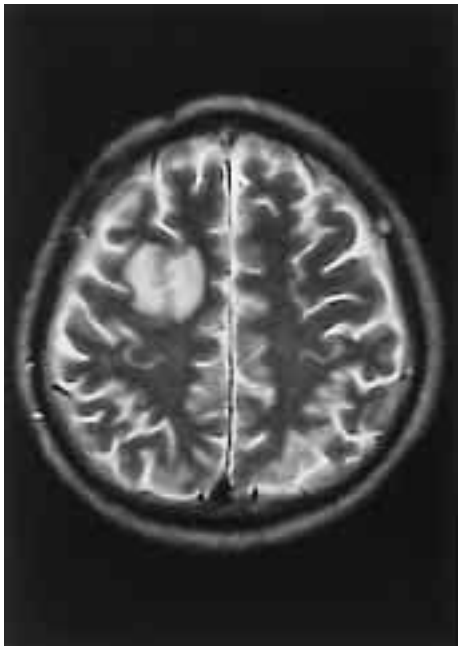

Fig. 2 Extension of the lesion into the frontal lobe.

ratio). The L/N ratios in these ROIs were extremely high, ranging from 5.13 to 16.2. Chest and abdominal CT, whole-body bone scintigraphy, and gallium scintigraphy for general scanning disclosed no abnormal findings. Meanwhile, the patient's symptoms and clinical laboratory findings gradually improved. Brain MRI (Fig. 4) performed on March 5 (48 days after the onset of symptoms) revealed a tendency towards reduction in the extent of the lesions. A diagnosis of brain abscess was therefore made, based on the clinical course. ^{201}Tl SPECT performed on March 16 (59 days after the onset of symptoms) revealed no evidence of abnormal radionuclide accumulation (Fig. 5). The patient was discharged on March 19, 2001.

DISCUSSION

^{201}Tl scintigraphy has been found to be useful for differentiating between benign and malignant brain tumors, and for assessing the effects of radiotherapy in brain tumors.[1,2] Relatively few studies, however, have reported accumulation of ^{201}Tl in cases of brain abscess or other inflammatory diseases of the brain, such as encephalitis, even though lesions in aspergillosis, candidiasis and toxoplasmosis have been reported to accumulate the radionuclide.[6–11] In our patient, the multiple brain abscesses detected by SPECT corresponded almost exactly to those detected by MRI. Few studies with ^{201}Tl scintigraphy on brain abscesses have described the changes in radionuclide accumulation over time. Tonami et al.[7] carried out ^{201}Tl scintigraphy twice in a patient with candida encephalopathy, the first about one month after the onset of symptoms, and the second several months later, when the symptoms had improved. Their initial imaging findings

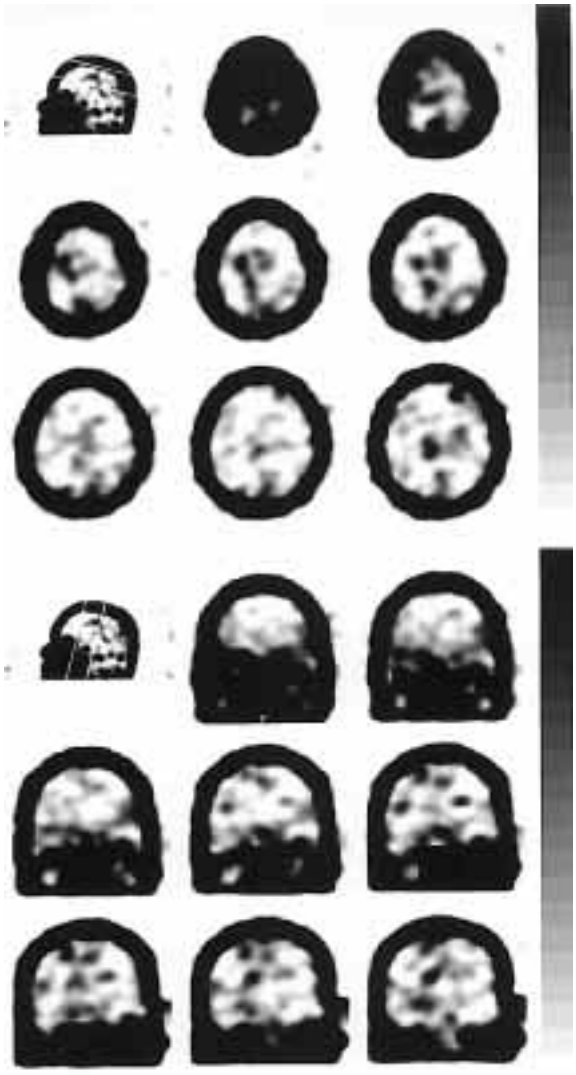

Fig. 3 ^{201}Tl scintigraphy of the head obtained on January 31. Abnormal accumulation was noted in the right frontal and parietal lobes and the left frontal lobe.

revealed abnormal accumulation in many areas in the brain, and the findings in the second imaging several months later showed only two abnormal areas of accumulation. Their longitudinal scintigraphic findings were similar to those in our patient. As far as we know, other studies on ^{201}Tl scintigraphy in such cases have presented their findings only at a certain time and in isolated cases, without any follow-up.[8–10]

Tumoral uptake of ^{201}Tl may be influenced by Na-K ATPase activity, lesional blood flow, the histological characteristics of the lesion, permeability of the cell membrane, and disruption of integrity of the blood-brain barrier (BBB).[12,13] As in the case of brain tumors, accumulation of ^{201}Tl in a cerebral abscess may also be related to the histological changes, especially severe disruption of integrity of the BBB.

Brain abscesses are classified into four disease stages:

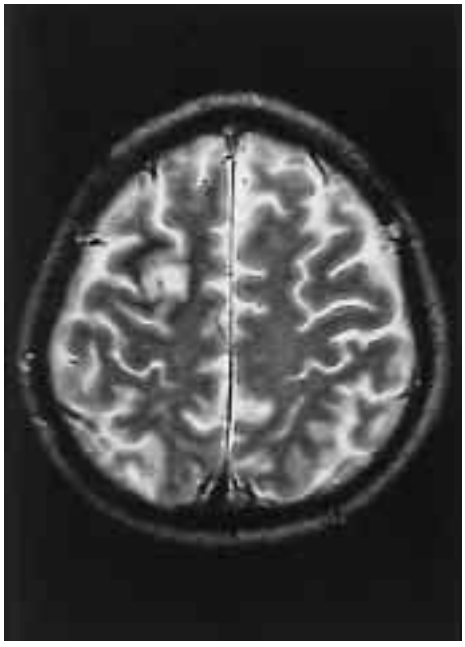

Fig. 4 T2-weighted image in brain MRI obtained on March 5. In comparison to Figure 2, the abnormal intensity is found to be decreased in size.

1) early cerebritis (1 to 3 days after infection), 2) late cerebritis (4 to 9 days after infection), 3) early capsule formation (10 to 13 days after infection), and 4) late capsule formation (several weeks to several months after infection).[14] Enhancement on contrast-enhanced CT or MRI has been shown to occur in the late cerebritis and thereafter, corresponding to the period of progression of disruption of integrity of the BBB or neovascularization. Since ^{201}Tl scintigraphy also revealed abnormal accumulation during these phases in our patient, radionuclide accumulation in brain abscesses may also be influenced by disruption of integrity of the BBB and an increase in blood flow to the lesion.

Although few studies with ^{201}Tl scintigraphy in cases of brain abscess have described the changes in radionuclide accumulation over time, or the relationship of the changes to findings of other imaging methods, such as CT or MRI, Tonami et al.[7] reported carrying out ^{201}Tl scintigraphy in a patient with candida encephalopathy within a month of onset of the symptoms, in whom the initial CT had revealed a brain abscess. Therefore, the time at which they performed ^{201}Tl scintigraphy perhaps corresponded to late cerebritis, or early capsule formation. Although other ^{201}Tl scintigraphy reports in cases of brain abscess have not referred to the exact date of onset of the symptoms, the reported abnormalities detected with other imaging methods, such as CT or MRI conducted simultaneously, corresponded to those detected by scintigraphy, which suggests disruption of integrity of the BBB and increase in blood flow to the lesion as being the bases for

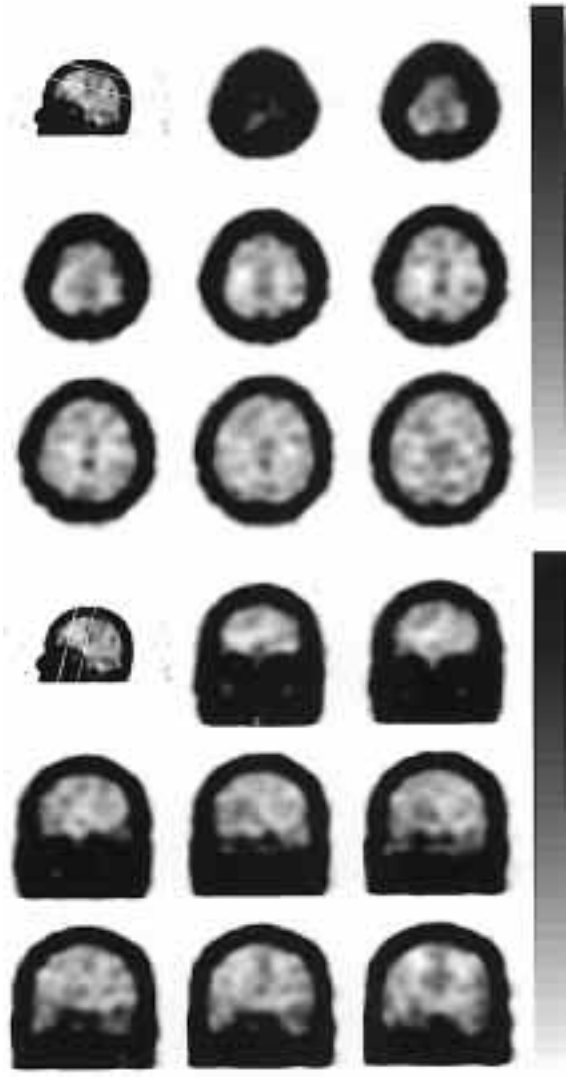

Fig. 5 ^{201}Tl scintigraphy of the head. The abnormal accumulation is found to have disappeared.

the SPECT findings.

The ratio of uptake by the lesion to that by the normal brain (L/N ratio) is known to be useful for evaluating of ^{201}Tl scintigraphic findings. The L/N ratio has been reported to be about 2.0 in malignant and benign tumors, and about 1.0 in cases of brain abscess, but the L/N ratio in our patient was extremely high, ranging from 5.13 to 16.2. The L/N ratio was of little diagnostic help in this case. Many previous studies that used the L/N ratio to evaluate brain abscesses have also reported values for this ratio of more than 2.0.

Recent studies have indicated the usefulness of the late image count/early image count ratio (L/E ratio), or the washout ratio.[10]

In our patient, brain abscess was strongly suspected based on the clinical findings, but imaging findings did not allow definitive exclusion of other diseases, in particular of metastatic brain tumors. The positive radionuclide accumulation in ^{201}Tl scintigraphy in our case underscores the possibility of radionuclide accumulation also in non-tumoral lesions, such as brain abscesses, that are associated with disruption of integrity of the BBB, or other factors still to be analyzed. Careful follow-up and measurement of the washout ratio are therefore also important for the diagnosis of cerebral lesions, besides ^{201}Tl scintigraphy.

REFERENCES

1. Kim KT, Black KL, Marciano D. ^{201}Tl SPECT imaging of brain tumours; methods and results. *J Nucl Med* 1990; 7: 249–257.
2. Biersack HJ, Grunwald F, Kropp J. Single photon emission computed tomography imaging of brain tumours. *Semin Nucl Med* 1991; 21: 2–10.
3. Ancri D, Basset JY, Longchampt MF, Etavard C. Diagnosis of cerebral lesions by thallium-201. *Radiology* 1978; 128: 417–422.
4. Ancri D, Basset JY. Diagnosis of cerebral metastases by thallium-201. *Br J Radiol* 1980; 53: 443–453.
5. Ramanna L, Waxman AD, Binney G. Increasing specificity of brain scintigraphy using Tl-201 [Abstract]. *J Nucl Med* 1987; 28: 658.
6. Cox J, Murtagh FR, Wilfong A, Brenner J. Cerebral aspergillosis. *Am J Neuroradiol* 1992; 5: 1489–1492.
7. Tonami H, Matsuda H, Ooba H, Yokoyama K, Hisada K, Ikeda K, et al. Thallium-201 accumulation in cerebral candidiasis. *Clin Nucl Med* 1990; 15: 397–400.
8. Martinez Del Valle MD, Gomez-Rio M, Horcajadas A, Rodoriguez-Fernandez A, Muros De Fuentes MA, Acosta-Gomez M. False positive thallium-201 SPECT imaging in brain abscess. *Br J Radiol* 2000; 73: 160–164.
9. Krishna L, Slizofski WJ, Katsetos CD, Nair S, Dadparvar S, Brown SJ. Abnormal intracerebral thallium localization in a bacterial brain abscess. *J Nucl Med* 1992; 33: 2017–2019.
10. Sato S, Ogasawara K, Kinouchi H, Kohsyu K, Yoshimoto T. Probable brain abscess. Presenting as a high uptake lesion on thallium-201 single photon emission computed tomography. Case report. *Neurol Med Chir* 1997; 37: 775–778.
11. Enzmann DR, Britt RH, Placone R. Staging of human brain abscess by computed tomography. *Radiology* 1983; 146: 703–708.
12. Brismar T, Collins VP, Kesselberg M. Thallium-201 uptake relates to membrane potential and potassium permixbility in fuman glioma cells. *Brain Research* 1974; 500: 30–36.
13. Waxman AD, Lee G, Siemsen JK. Gallium brain scanning and the differential diagnosis of brain tumors. *Clin Res* 1973; 21: 277.