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Central neurocytoma with unusually intense FDG uptake: Case report

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Central neurocytoma is a benign neuronal tumor with a favorable prognosis. This tumor is typically characterized by decreased uptake of ^{18}F-fluorodeoxy glucose (FDG) and any increased uptake of FDG in patients suffering from this tumor would be highly unusual. A case of central neurocytoma with an intense FDG uptake, combined with atypical histopathological features and a high proliferation index is reported in this paper. A 45-year-old male had a two months' history of right hemiweakness. Magnetic resonance (MR) imaging showed a large tumor in the right lateral ventricle. Positron emission tomography (PET) with FDG revealed high glucose metabolism in the tumor. The histological diagnosis was central neurocytoma with atypical features characterized by microvascular proliferation. The MIB-1 labeling index, ordinarily smaller than 2.0%, was 7.0%. Conventional radiotherapy, with a total dose of 50 Gy, was administered after the surgical treatment. The patient returned to his normal daily activities after the cessation of radiation therapy.

Key words: central neurocytoma, 2-[fluorine-18]fluoro-2-deoxy-D-glucose, positron emission tomography, MIB-1 labeling index

INTRODUCTION

CENTRAL NEUROCYTOMA is a benign neuronal tumor with a favorable prognosis and a low proliferation rate[1,2] but an MIB-1 labeling index greater than 2% indicates a significantly shorter recurrence-free interval in a patient with central neurocytoma.[3,4,5] Positron emission tomography (PET) studies show that the metabolic rate for glucose in the tumor is significantly lower than that in the gray matter.[5] In the present case, the authors describe an extremely rare case of central neurocytoma with intense FDG uptake, combined with atypical histological features and a noticeably high MIB-1 labeling index.

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CASE REPORT

A 45-year-old male with a two month history of right hemiweakness was admitted to our hospital. Mild right hemiparesis and papilledema were observed in the course of a physical examination, but laboratory findings were within normal limits. A cranial computed tomographic (CT) scan indicated a large isodense area in the right lateral ventricle. There was a noticeable contrast enhancement in this lesion. Magnetic resonance (MR) imaging at 1.5 T revealed a tumor 6.0 × 5.0 × 4.8 cm in size (Signa Horizon LX, GE Medical Systems, Milwaukee, Wisconsin, USA). A low signal intensity mass with heterogenous contrast enhancement was observed on axial T1-weighted (T1W) images (Fig. 1). T2-weighted (T2W) images revealed a mixed signal intensity mass. MR venography showed a mass effect only, and cerebral angiography was not performed because of the patient's drug allergy.

The patient fasted for 18 hours and was injected with 311 MBq of FDG. Static brain images with FDG were obtained at 60 min postinjection with the simultaneous emission-transmission technique.[6] FDG PET revealed

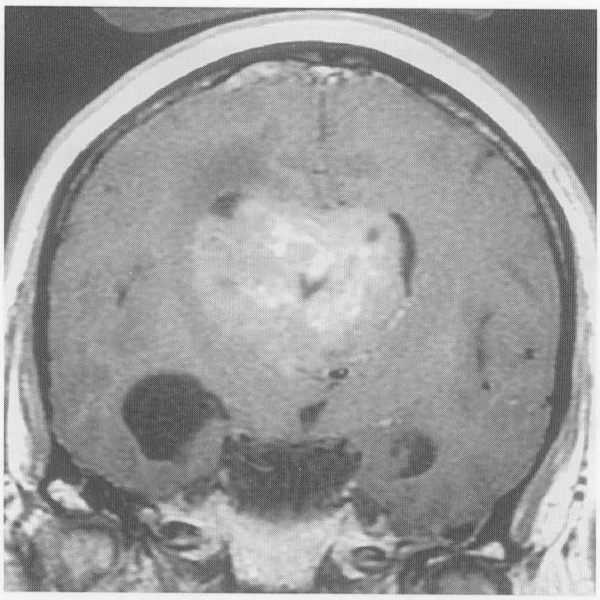

Fig. 1 T1-weighted gadolinium-enhanced MR image before surgery showing a large tumor with a microcystic component and heterogeneous enhancement in the right lateral ventricle.

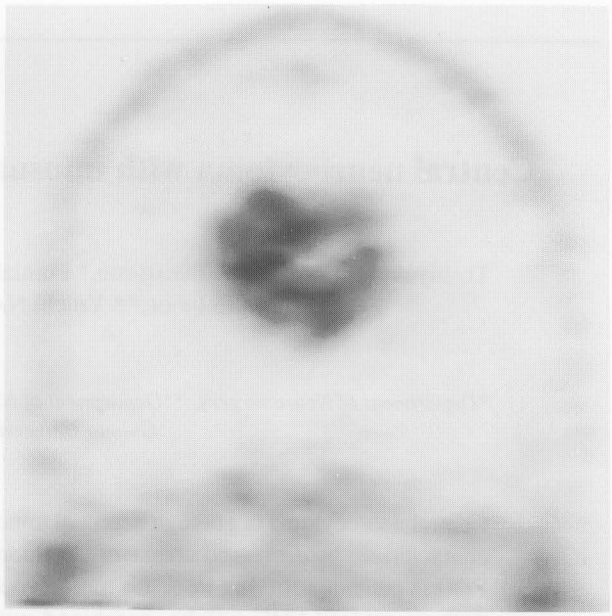

Fig. 3 The coronal image of ^{11}C choline PET scan showing marked accumulation of ^{11}C choline in the intraventricular tumor.

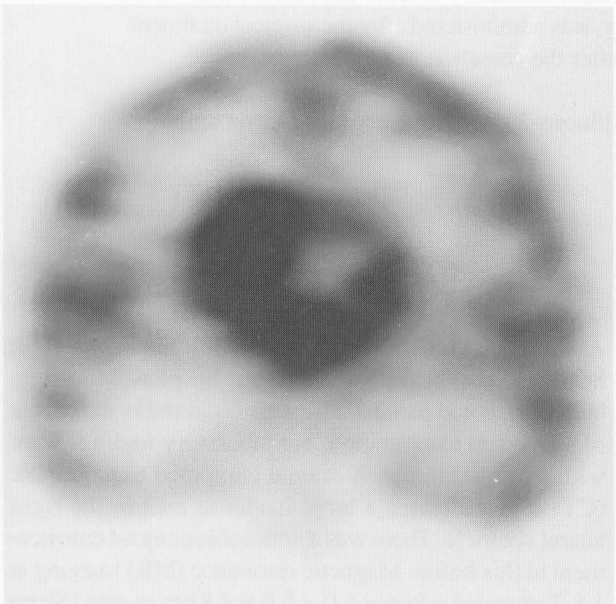

Fig. 2 The coronal image of FDG PET scan before surgery showing intense FDG uptake by the tumor with a standardized uptake value (SUV) of 13.27 (compared with SUV of 7.00 in the normal cortex).

high glucose metabolism in the tumor with a standardized uptake value (SUV) of 13.27 compared with that of 7.00 in the normal cortex (Fig. 2). PET with ^{11}C choline was performed and noticeable accumulation of ^{11}C choline in the intraventricular tumor was observed (Fig. 3). Single-photon emission computed tomography (SPECT) with

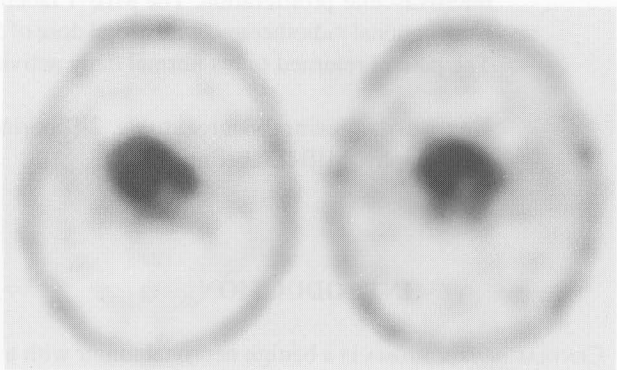

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Fig. 4 The transaxial images of ^{201}Tl SPECT. a) Early ^{201}Tl SPECT image showing intense tumor uptake in the right lateral ventricle. b) Delayed ^{201}Tl SPECT image showing slightly increased accumulation of the tumor compared to that of an early ^{201}Tl SPECT image.

thallium-201 (^{201}Tl) and *N*-isopropyl-I-123-p-iodoamphetamine (^{123}I IMP) was also performed. Early ^{201}Tl SPECT images revealed intense uptake of the tumor in the right lateral ventricle and its accumulation increased on delayed images (Fig. 4). ^{123}I IMP SPECT images showed high accumulation of the tumor on early images, but its accumulation decreased on delayed images (Fig. 5).

First we diagnosed a central neurocytoma, or other malignant brain tumor. A transcortical transventricular approach with right frontal craniotomy was performed. Subtotal removal of the tumor was achieved without any damage to the fornix, thalamus and caudate nucleus or

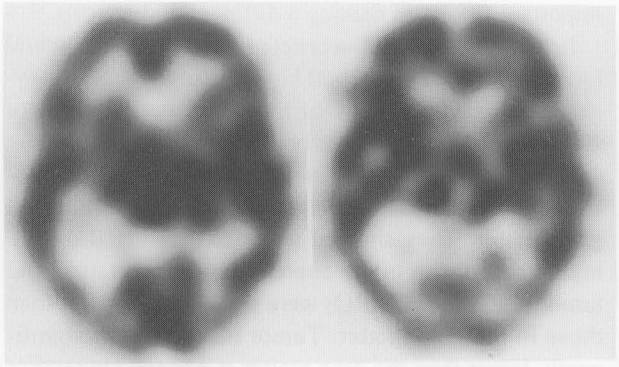

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Fig. 5 The transaxial images of ^{123}I IMP SPECT. a) Early ^{123}I IMP SPECT image showing high tumor accumulation in the right lateral ventricle and decreased accumulation in the right cerebral cortex due to the mass effect. b) Delayed ^{123}I IMP SPECT image showing decreased tumor accumulation compared to that of an early ^{123}I IMP SPECT image.

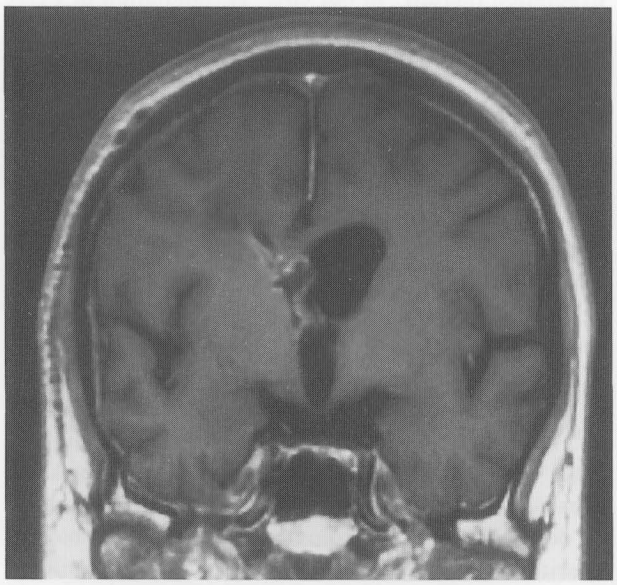

Fig. 6 Postoperative T1-weighted gadolinium-enhanced MR image showing a large tumor in the right lateral ventricle subtotally removed.

other regions. A postoperative T1-weighted gadolinium-enhanced MR image showed that the large tumor in the right lateral ventricle had been removed (Fig. 6). Histopathological examination including synaptophysin expression revealed a central neurocytoma with atypical features characterized by microvascular proliferation (Figs. 7, 8). The MIB-1 labeling index was 7.0%. Conventional radiotherapy, total dose 50 Gy, was administered after the surgical treatment. Intense FDG uptake in the residual tumor had disappeared on the FDG PET image obtained after the completion of radiation therapy (Fig. 9). The patient returned to his normal daily activities 10 weeks after the operation.

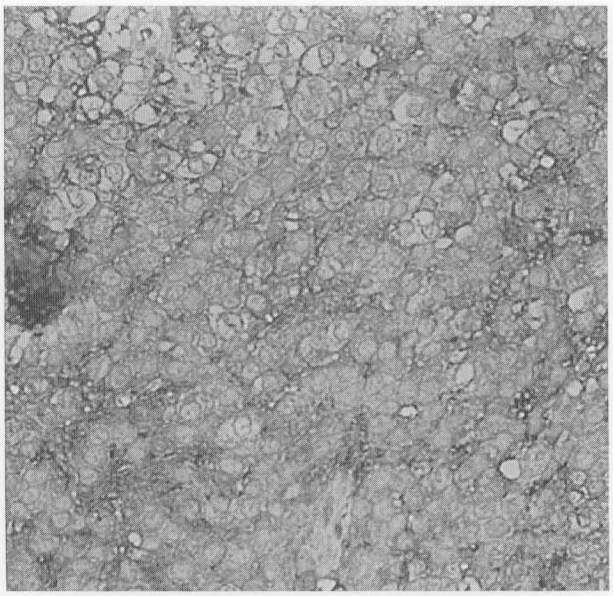

Fig. 7 Photomicrograph showing synaptophysin expression characteristic of central neurocytoma (synaptophysin immunohistochemical stain). Original magnification × 100.

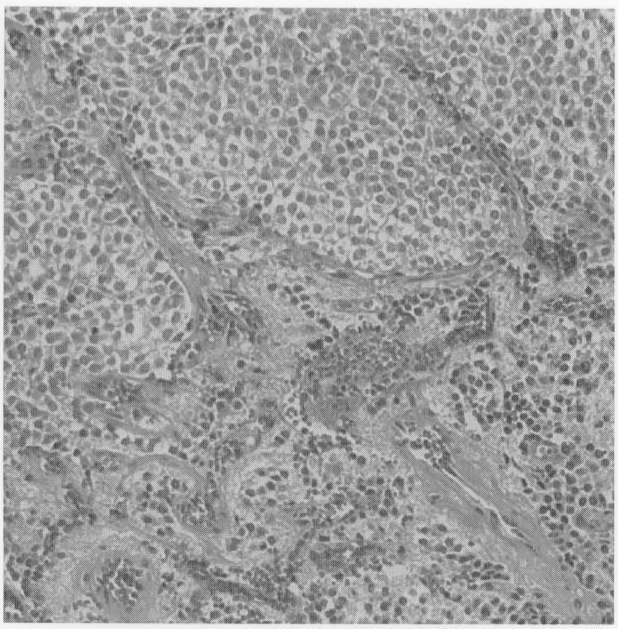

Fig. 8 Photomicrograph showing tumor cells with atypical features including microvascular proliferation (hematoxylin and eosin stain). Original magnification × 40.

DISCUSSION

Central neurocytoma is a benign intraventricular neoplasm composed of uniform round cells with neuronal differentiation and characterized by an indolent growth and a low recurrence rate. Many previously reported central neurocytomas did not recur after tumor removal,

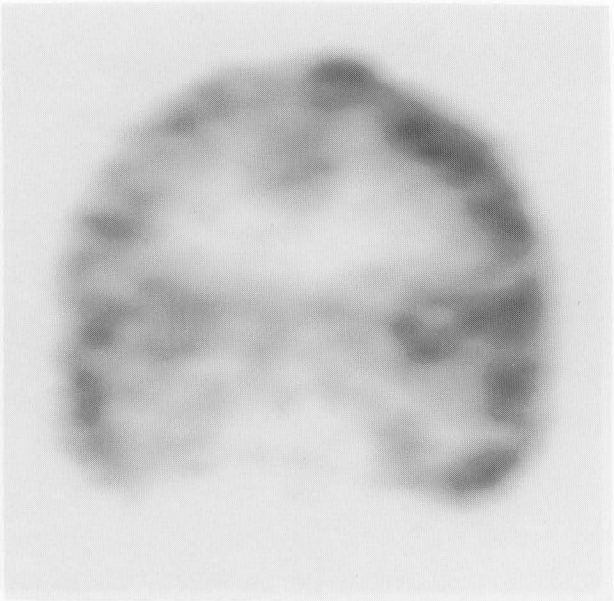

Fig. 9 The coronal image of FDG PET scan following surgery and radiotherapy showing no apparent residual FDG uptake in the tumor.

and the patients had favorable postoperative outcomes.[7,8]

In some instances, histologic atypia including cellular pleomorphism, endothelial proliferation, mitosis, and necrosis have been observed.[2,3] Although some regrowth or recurrent cases did not show any histologic atypia,[9] atypical histologic findings are usually associated with a somewhat less favorable clinical course.[2,3,4] Proliferative activity of central neurocytoma is measured by proliferating cell nuclear antigen (PCNA), nuclear organizer region (NOR), Ki-67, bromodeoxyuridine labeling index, and a widely-used MIB-1 labeling index.[10,11,12] Central neurocytomas usually have a low proliferative index, but recent reports show that a central neurocytoma with an MIB-1 labeling index greater than 2% had a significantly shorter disease-free survival period, and these tumors are reported to be atypical central neurocytomas which exhibited histologically microvascular proliferation, mitosis, and necrosis, or a combination of them.[3,4] Central neurocytoma is therefore classified as a new World Health Organization (WHO) Grade 2 lesion.[2]

A CT scan showed an iso-hyperdense mass (as compared with the density of gray matter) with small calcification, intratumoral cysts of various sizes, heterogeneous enhancement and a well-circumscribed tumor.[13,15] MRI showed isointensity or slightly high intensity on T1-weighted images, and with several attachments mainly to the septum pellucidum, fornix and the caudate head.[13,14,15] These neuroimaging findings prove useful in eliminating alternative diagnoses such as ependymomas, choroid plexus papillomas, subependymal giant cell astrocytomas and meningiomas, whereas the age of the patient and the location of the tumor within the lateral ventricle are important factors in making a differential diagnosis.[15]

In a PET study by Mineura et al.,[5] the regional cerebral blood flow (rCBF), cerebral blood volume (rCBV), oxygen extraction fraction (rOEF), cerebral metabolic rate of oxygen ($rCMRO_2$), and cerebral metabolic rate of glucose (rCMRGl) of the central neurocytoma were quantitatively analyzed in tumor lesions and in the contralateral gray matter. They showed that rCBF and rCBV were higher than those in the contralateral gray matter, and tumor rOEF and $rCMRO_2$ were significantly lower than those in the gray matter. Tumor rCMRGl was significantly lower than the gray matter rCMRGl. One tumor exhibited almost the same rCMRGl value as that of gray matter, but the proliferative index of the tumor was not mentioned in their report, and it had increased in size 4 months after partial resection. The authors concluded that tumor rCMRGl may be an indicator of proliferating activity in central neurocytoma. No other reports give a description of the findings of repeated FDG PET after irradiation therapy. In our case, accumulation of FDG with residual tumor after irradiation therapy decreased noticeably. This indicates that FDG PET has the potential to be used in the follow up examination. PET with ^{11}C choline for central neurocytoma is not described in the literature to the best of our knowledge. Our case indicates that central neurocytoma with a high proliferative index shows signs of intense ^{11}C choline uptake, but such an accumulation is not known in the tumor with a low proliferative index, common central neurocytoma.

SPECT images of central neurocytoma have been described by Oguchi et al.[16] and the authors reported a case of central neurocytoma which demonstrated a high uptake of technetium-99m-hexamethyl-propyleneamine-oxime (^{99m}Tc HMPAO) and ^{201}Tl before biopsy of the tumor. Early ^{123}I IMP SPECT images revealed intense uptake of a residual tumor after biopsy, but its uptake had decreased on delayed images. Histological findings of the biopsy specimen showed central neurocytoma with capillary dilatation, but they did not reveal either microvascular proliferation or the MIB-1 labeling index. In our case, ^{201}Tl and ^{123}I IMP SPECT images revealed the same results as previously reported.[16] ^{201}Tl uptake was thought to reflect the viability of the tumor. ^{201}Tl uptake was found to correlate adequately with the cell growth rate and to represent tumor malignancy.[17] ^{123}I IMP uptake depends on amine binding sites, so that decreased uptake implies a deficiency of amine binding sites in brain tumors.[18]

The most effective management of central neurocytoma is surgical removal of the tumor. The anterior transcallosal approach or anterior transcortical approach is widely used.[19] Total removal of the tumor is ideal for treatment of the central neurocytoma, but in many cases subtotal removal was achieved without removal of the attachment of this tumor to the fornix, choroid plexus or caudate head. Although radiation therapy for the residual

tumor appears to have an effect on tumor control,[20, 21] we have to decide carefully whether to perform irradiation therapy because it may cause delayed complications, and a good clinical outcome is reported for many subtotally resected patients who do not receive irradiation therapy.[21] Radiation therapy is appropriate as an adjuvant therapy for central neurocytoma with high proliferating activity, because those tumors regrow easily after surgical removal.

The present case of central neurocytoma showed intense FDG uptake, associated with atypical histological features and a very high MIB-1 labeling index. This is the first documented case to our knowledge that shows intense FDG uptake of central neurocytoma compared to that of gray matter combined with a high proliferative index of this tumor. This case indicated that FDG PET may predict the proliferation potential of central neurocytoma, and it may lead to more efficient therapeutic management.

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