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ORIGINAL ARTICLE

Radiological features of cerebellar glioblastoma

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KEYWORDS
Cerebellar glioblastoma;
Computed tomography;
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Summary
Background and propose: Glioblastoma (GBM) is the most common type of malignant primary central nervous system tumor in adults; however, the prevalence of GBM arising in the cerebellum is extremely low. This study aimed to demonstrate the radiological features of cerebellar GBMs, including computed tomography (CT), magnetic resonance imaging (MRI), diffusion-weighted imaging (DWI), and ^{18}F-fluorodeoxyglucose (FDG)- and ^{11}C methionine (MET)-positron emission tomography (PET) findings.
Materials and methods: We retrospectively reviewed seven patients with cerebellar GBM (six men and one woman: mean age: 56 years, range: 18—73 years). We reviewed medical records and radiological data, including preoperative CT, MRI and PET. All patients underwent CT and MRI. DWI data were acquired in four patients. Three patients underwent FDG- and MET-PET examinations. All patients underwent total or subtotal tumor resection and received pathological diagnoses.
Results: Four patients had imaging findings consistent with GBM and received preoperative cerebellar GBM diagnoses. Two patients exhibited homogeneous patchy and nodular enhancement without necrosis on MRI, which resembled malignant lymphoma and metastasis. One case exhibited Lhermitte—Duclos disease-like parallel linear striations (i.e.,''tiger-striped'' appearance). Although the imaging findings of these three patients were inconsistent with GBM, pathological diagnosis confirmed cerebellar GMB.

Abbreviations: GBM, Glioblastoma; CNS, Central nervous system; PCNSL, Primary central nervous system lymphoma; CT, Computed tomography; MRI, Magnetic resonance imaging; CT, Computed tomography; DWI, Diffusion-weighted imaging; FGD, ^{18}F-fluorodeoxyglucose; MET, ^{11}C methionine; PET, Positron emission tomography; NCCT, Noncontrast CT; T1WI, T1-weighted image; T2WI, T2-weighted image; FLAIR, Fluid-attenuated inversion recovery; Gd, Gadolinium; ADC, Apparent diffusion coefficient; TSE, Turbo spin echo; ADC_{min}, Minimum ADC; SUV_{max}, Maximum standard uptake value; rCBV, Relative cerebral blood volume; SOL, Space occupying lesion.

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Conclusions: Some evaluated cases of cerebellar GBM did not exhibit the common CT, MRI, and PET findings of supratentrial GBM, leading to considerable difficulty with preoperative differential diagnosis.

Introduction

Glioblastoma (GBM) is the most common type of malignant primary central nervous system (CNS) tumor in adults; however, the prevalence of GBM arising in the cerebellum is extremely low. According to a report from the Brain Tumor Registry of Japan, GBM in the cerebellum accounts for 2.1% of all GBMs and 0.15% of all brain tumors [1]. Cerebellar GBM, an even rarer histiotype, has been the subject of several reports [2—15].

In adult patients, a possible preoperative diagnosis of a cerebellar tumor may be based on the age of onset and imaging features. Malignant glioma is rarely considered in the preoperative differential diagnosis. Although the possibility of glioma is noted, primary consideration is given to metastatic brain tumor, hemangioblastoma, and primary CNS lymphoma (PCNSL) [13]. This study aimed to demonstrate the radiological features of cerebellar GBMs, including computed tomography (CT), magnetic resonance imaging (MRI), diffusion-weighted imaging (DWI), and ^{18}F-fluorodeoxyglucose (FDG)- and ^{11}C methionine (MET)-positron emission tomography (PET) findings.

Materials and methods

Our institutional review board approved this study. The requirement to obtain written informed consent was waived because of the retrospective study design.

We retrospectively reviewed patients with glioma who underwent craniotomy or stereotactic biopsy at our hospital from March 2003 to June 2014. The inclusion criterion was pathologically proven GBM in an adult patient (age > 18 years). Patients with supratentrial GBM were excluded. Seven patients (six men and one woman: mean age: 56 years, range: 18—73 years) satisfied these criteria and were included in the study. We reviewed these patients' medical records and radiological images, including preoperative noncontrast CT (NCCT), MRI and PET data. All patients underwent NCCT and MRI [T1- and T2-weighted images (WIs), fluid-attenuated inversion recovery (FLAIR), and gadolinium (Gd)-enhanced T1WI]. DWI data were obtained for four patients, and apparent diffusion coefficient (ADC) maps were also calculated. Three patients underwent FDG- and MET-PET examinations.

MRI examinations were performed on a 1.5-T (n = 3) or 3-T system (n = 4). T2WIs were obtained using a turbo spin echo (TSE) sequence, T1WIs were obtained using a spin echo or TSE sequence with inversion recovery, and FLAIR was obtained using a TSE sequence with inversion recovery. Contrast medium was used in a conventional manner at a dose of 0.1 mmol/kg body weight. DWIs were obtained using a single-shot echo planar sequence with b values of 0 and 1000 s/mm^2. ADC maps were automatically generated on an MRI console. ADC values were measured in the solid portions of tumors according to information from Gd-enhanced T1WI, and the minimum ADC values (ADC_{min}) were used for the evaluation [16,17].

PET studies were performed in a three-dimensional acquisition mode. Images were acquired while patients rested in the supine position with their eyes closed. MET-PET data were acquired for 20 min, beginning at 20 min after the administration of an MET dose of 5 MBq/kg body weight. For the FDG-PET study, enteral and parental sources of glucose were withheld for at least 6 h before the examination. The PET scan was initiated 90 min after the administration of an FDG dose of 3.5 MBq/kg body weight while the patient rested in the supine position in a room with low ambient light. Emission data were acquired for 20 min. The maximum standard uptake values (SUV_{max}) of tumors during MET and FDG-PET were obtained using the pixel values from a region of interest placed over the tumor in reference to Gd-enhanced T1WI data.

All patients were treated via total or subtotal tumor resection. Pathological diagnoses were made according to the following criteria: marked neovascularity, variable mitotic activity, increased cellularity, nuclear pleomorphism, and microscopic evidence of necrosis [18].

Results

Table 1 summarizes the clinical features of the seven patients in our series. The most common symptom was ataxia (n = 3), followed by headache, vomiting, and dizziness (n = 2). One patient had no symptoms, and the tumor was found during a follow-up examination for a cerebral infarction. In all cases, the primary tumors were located in the cerebellar hemisphere and vermis, with simultaneous lesions in the pons in one case.

The tumor locations and radiological features are summarized in Table 2. The NCCT imaging findings of four patients revealed areas of low density in the cerebellar hemisphere

Table 1 Clinical features of the patients.

No.	Age/gender	Symptom
1	33/M	Headache
2	71/F	None
3	70/M	Ataxia
4	71/M	None
5	56/M	Dizziness, ataxia
6	18/M	Headache, vomiting, ataxia, nystagmus
7	73/M	Dizziness, vomiting