

CASE REPORT

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A case of disseminating central neurocytoma increased methionine uptake

Akira Tempaku

ABSTRACT

Introduction: Central neurocytoma is one of the benign central nervous system neoplasms, typically identified through imaging studies of the head, without any neurological deficits. However, occasional growth or dissemination may cause central nervous system disorders due to hydrocephalus. Radiographical findings can sometimes make it difficult to detect increased lesions.

Case Report: A 56-year-old man presented with hydrocephalus. This was caused by expansion of the central neurocytoma, which was caused by intratumoral hemorrhage. The tumor was diagnosed through pathological analysis after a biopsy and third ventriculostomy. Half a year after the diagnostic surgery, he experienced a recurrence of hydrocephalus. This was accompanied by cognitive dysfunction. Positron emission tomography (PET) with ¹¹C-methionine uptake showed disseminated neoplastic lesions surrounding the ventricle walls.

Conclusion: The methionine PET study revealed a rare case of central neurocytoma. Cases of this tumor that have disseminated or transformed exhibit increased cell viability, including protein synthesis. These changes result in increased methionine accumulation in tumor lesions.

Keywords: Central neurocytoma, Dissemination, Methionine, PET

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INTRODUCTION

Central neurocytoma accounts for 0.5% of primary brain tumors [1–3]. It is more prevalent in the 20–40 age group and is predominantly intraventricular [2]. The World Health Organization (WHO) classifies it as a grade II brain tumor. However, progression of hydrocephalus obliterans and pressure on the brain parenchyma associated with tumor growth may lead to impaired consciousness and abnormal neurological findings [4–6]. Optic disc edema associated with cerebral hypertension sometimes results in visual disturbance being the initial presenting complaint. However, in most cases, it is usually diagnosed incidentally on a head magnetic resonance image (MRI) or computed tomography (CT) scan. Central neurocytoma is characterized as a slow progressive tumor, with few events of malignant transformation.

The author encountered a case of central neurocytoma, whereby the tumor spread from the pineal region of the third ventricle to the thalamus, the wall of the fourth ventricle and the cerebellum. It disseminated through the cerebrospinal cavity. As the tumor grew, it degenerated due to the accumulation of methionine. It was found that central neurocytoma with disseminated or enlarged components could be detected using ¹¹C-methionine positron emission tomography (PET). The author presents the case and discusses the pathophysiology. This case had the rapid progression with malignancy transition, which was speculated by the change of the methionine uptake pattern.

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CASE REPORT

The patient was a 56-year-old man. The author has been conducting imaging studies on him over time due to a mass in the third ventricle. The mass was found by chance one year ago. The mass lesion was gradually enlarged (Figure 1A) for a half year. During the continuous observation, he was diagnosed with obstructive hydrocephalus due to the enlargement of the mass caused by intratumoral hemorrhage (Figure 1B) at the seven months later from the first diagnosis. The patient presented with a mild disturbance of consciousness (3 points on the Japanese Coma Scale and 13 points on

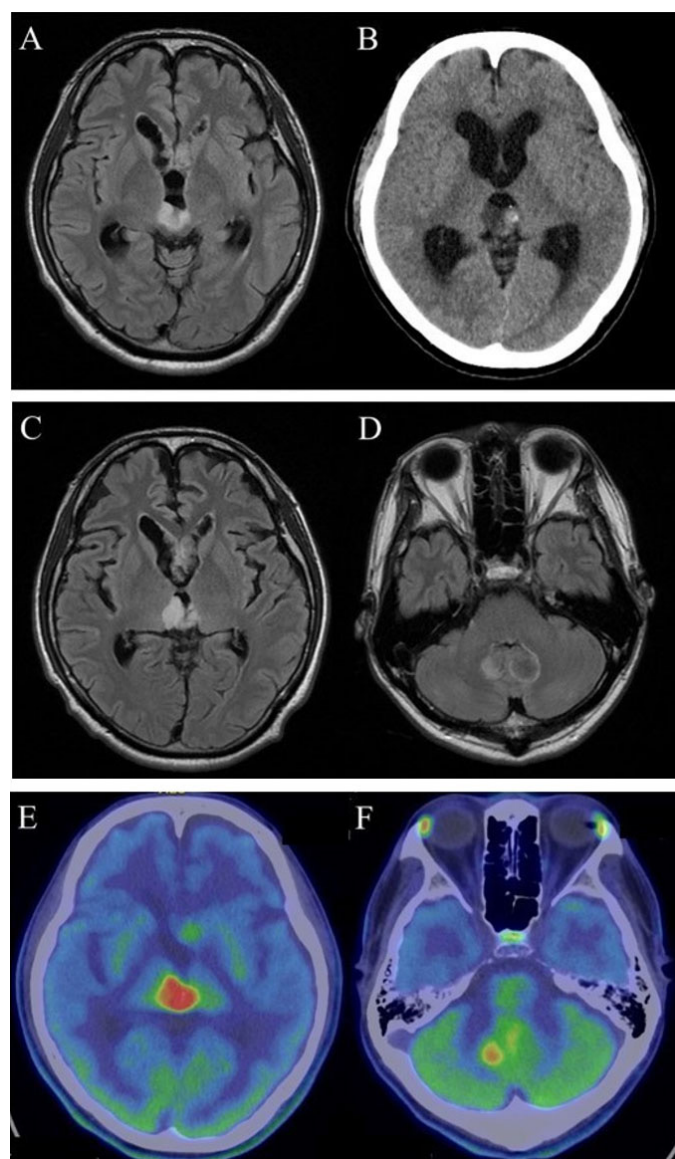


Figure 1: (A) A magnetic resonance imaging (MRI) scan of the head with fluid-attenuated inversion recovery (FLAIR) during the observation period. (B) A computed tomography scan of the head at the time of admission, showing hydrocephalus. (C and D) The head MRI with FLAIR at the time of tumor regrowth. (E and F) Positron emission tomography images of the head with ^{11}C -methionine at the time of tumor regrowth. (C and E) The third ventricle including the axial slice. (D and F) The cerebellum including the axial slice.

the Glasgow Coma Scale, with 4 marks for eye response, 4 for verbal response and 5 for movement). The patient marked normal range vital signs without any hemipalsies. Under general anesthesia, a flexible endoscope (Olympus, Tokyo, Japan) was inserted into the right ventricle via a puncture in the right anterior horn through one burr hole. An endoscopic biopsy was then performed alongside third ventriculostomy. The neurological symptoms associated with hydrocephalus were resolved. A pathological examination revealed a diffuse tumor cell growth with basophilic cytoplasm and uniform, round nuclei. There was no mitosis or necrosis. Immunostaining revealed that the tumor cells were glial fibrillary acidic protein (GFAP)-positive (10%), oligodendrocyte lineage transcription factor 2 (Olig2)-positive, synaptophysin positive, neuron specific enolase (NSE) γ -positive, Chromogranin A-negative, isocitrate dehydrogenase (IDH)1-negative, p53-wild type, and Ki67LI (5%). The cyto-histological features observed under microscopic examination following staining with synaptophysin and NSE are consistent with those of central neurocytoma, which is classified as a grade II tumor by the World Health Organization (WHO) 2021 CNS criteria. They were diagnosed as a central neurocytoma. The patient's neurological condition improved and he was discharged. However, over the next six months, he slowly developed higher brain dysfunction and ventricular enlargement. Head imaging revealed an enlarged residual mass after biopsy, as well as distant seeding along the ventricular wall from the thalamus to the cerebellum (Figure 1C and D). This was diagnosed using fluid attenuated inversion recovery (FLAIR) imaging. Methionine PET imaging revealed methionine accumulation in the high signal on the FLAIR image (Figure 1E,F). The standardized uptake value (SUV) was marked at 7.47 in the pineal region, where showed the most methionine accumulation. This was consistent with the suspected seeding lesion, confirming its enlargement. Due to recurrent hydrocephalus and ventricular enlargement, the patient underwent Tomotherapy (Accuray, Madison, WI, USA) involving 54 Gray of 27 times fractionated radiation therapy for the disseminated, enlarged mass. Over time, the residual mass appeared to shrink under the head MRI.

His brain function gradually deteriorated after radiotherapy. Cognitive impairment made it difficult for him to carry out daily activities independently. No motor dysfunction was observed. However, he experienced visual disturbances, such as hallucinations and decreased visual acuity. These were believed to be caused by rapidly progressing papilledema in the optic nerve. The patient was unable to live at home and was transferred to a convalescent hospital.

DISCUSSION

A central neurocytoma is a benign tumor with clearly defined borders that tends to be located in the ventricles.

In the absence of neurological symptoms, conservative treatment is the preferred approach. However, when neurological symptoms occur alongside cerebral hypertension, such as hydrocephalus, surgical resection, and opening of the floor of the third ventricle are preferred [7, 8]. Due to the tumor's benign nature and slow growth rate, the efficacy of chemotherapy is controversial [8–11]. Radiation therapy has been used in cases where the tumor is difficult to remove and for disseminated or enlarged lesions [7, 8, 12, 13].

Intrathecal seeding of residual lesions [14–17] resulted in more severe neurological symptoms [18, 19]. It is difficult to predict later progression or expansion toward the distal area at primary diagnosis [20]. Consequential radiological follow-up is required to estimate recurrent progression. Reports of distant metastasis in central neurocytoma have identified lesion expansion via MRI [16–19]. Positron emission tomography (PET) with 5-fluorodeoxyglucose (FDG) uptake has been used to detect central neurocytoma [21–23]. However, a second lesion resulting from dissemination or remote migration has never been reported in FDG-PET scans. Due to the high background of glucose uptake in the brain and lower accumulation of FDG in central neurocytoma [21–24], FDG-PET is limited in its ability to detect small lesions.

In contrast, evaluation of ¹¹C-methionine uptake using PET has been widely adopted for detecting intracranial tumors. However, the evaluation of methionine accumulation has been reported less frequently in central neurocytoma [24, 25]. One study has reported methionine accumulation in large central neurocytoma masses [26]. Ito reported the SUV of methionine in central neurocytoma is marked at 4.6. This present case showed much higher accumulation of methionine in the recurrent time than previously reported one. On the other hand, as far as the author was able to ascertain, it is not yet clear whether the spreading and enlargement of central neurocytoma lesions can be evaluated by PET with ¹¹C-methionine. However, strongly positive methionine accumulation would support the hypothesis of central neurocytoma transformation toward the malignancy.

Methionine accumulates during protein synthesis associated with cellular hypermetabolism [27, 28]. Consequently, methionine accumulation is typically low in benign tumors. In the present case, methionine accumulation was low immediately prior to the initial surgery. However, when the lesion enlarged again, methionine accumulated in high concentrations around the lesion. This pattern may indicate the activation or malignant transformation of the central neurocytoma.

Finally, in cases of acute hydrocephalus and altered consciousness without trauma, spontaneous nontraumatic brain hemorrhage must be considered as a differential diagnosis. Recent autopsy-based studies have shown that nontraumatic ICH and SAH can present without prior illness, especially in middle-aged males [29]. Advanced imaging, including methionine PET,

may help distinguish disseminated neoplasms from hemorrhagic events.

CONCLUSION

A central neurocytoma is a benign tumor of the central nervous system. In rare cases, it can disseminate or undergo malignant transformation with mass growth. Methionine PET scanning is useful for detecting disseminated lesions. Small lesions that do not enhance on gadolinium-enhanced MRI scans are sometimes difficult to evaluate for growth. Methionine PET could be the next diagnostic tool for central neurocytomas that have undergone pathophysiological transformation. That would need for prospective studies or serial PET imaging in similar patients.

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Author Contributions

Akira Tempaku – Conception of the work, Design of the work, Acquisition of data, Analysis of data, Interpretation of data, Drafting the work, Revising the work critically for important intellectual content, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Guarantor of Submission

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Written informed consent was obtained from the patient for publication of this article.

Conflict of Interest

Author declares no conflict of interest.

Data Availability

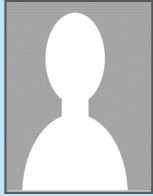
All relevant data are within the paper and its Supporting Information files.

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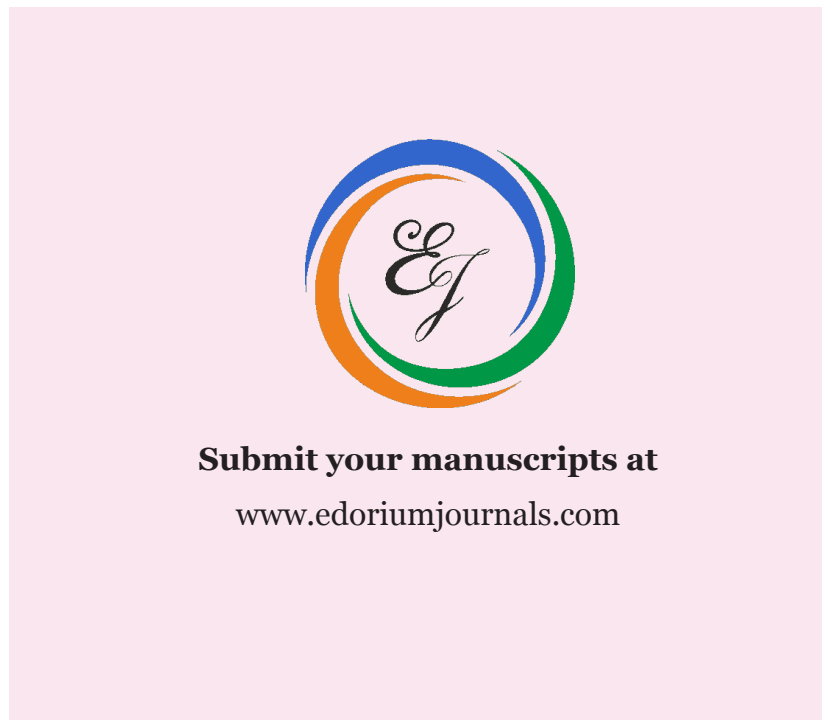
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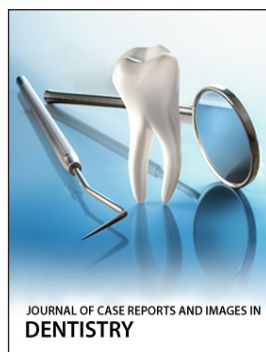
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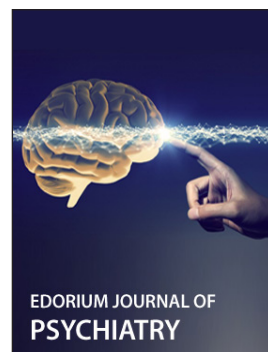
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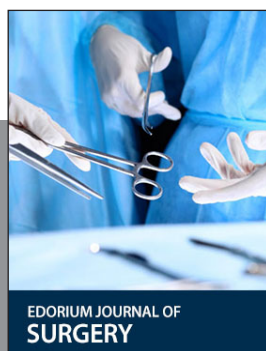
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