



The Potential Role of ^{18}F -FDG PET in the Early Detection of Basal Ganglia Germinoma in a 13-Year Old Patient with Diabetes Insipidus

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Abstract

Central nervous system (CNS) germ cell tumors (GCT) are a heterogeneous group of tumors arising predominantly in the midline structures of the pineal and/or suprasellar regions. Approximately, less than 14% of all intracranial GCTs occur in the basal ganglia or thalamus. It has been reported that a remarkable number of these patients experience a delay in time to diagnosis which may result in significant consequences. Therefore, to prevent this delay, introducing a non-invasive imaging modality with the ability of early detection of CNS-GCT is of pivotal importance. This case report signifies the potential role of ^{18}F -FDG PET scan in early diagnosis of a patient with Basal Ganglia Germ Cell Tumor, while other imaging studies were not confirmatory.

Keywords: Brain neoplasms; Germinoma; Basal ganglia disease; Positron emission tomography; Child

Abbreviations

CNS: Central Nervous System; GCT: Germ Cell Tumors; MRI: Magnetic Resonance Imaging; CT: Computed Tomography; PET: Positron Emission Tomography; ^{18}F -FDG: ^{18}F -Fluorodeoxyglucose; MET: ^{11}C -Methionine; SUV_{max} : Maximum Standardized Uptake Value

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Received Date: 30 May 2016

Accepted Date: 06 Jul 2016

Published Date: 10 Jul 2016

Citation:

Vali R, Shammass A, Khazae A, Widjaja E, Bouffet E. The Potential Role of ^{18}F -FDG PET in the Early Detection of Basal Ganglia Germinoma in a 13-Year Old Patient with Diabetes Insipidus. *Ann Clin Case Rep.* 2016; 1: 1052.

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Introduction

Central nervous system (CNS) germ cell tumors (GCT) are a heterogeneous group of tumors arising predominantly in the midline structures of the pineal and/or suprasellar regions [1]. The diagnosis of GCTs is based on clinical signs and symptoms, tumor markers, imaging, cytological cerebrospinal fluid (CSF) evaluation, and histologic confirmation. Computed tomography (CT) and magnetic resonance imaging (MRI) are commonly used in detecting GCTs. It has been reported that a significant number of patients with GCTs experience a delay in time to diagnosis, in some cases despite evaluation by general pediatrician and specialists [2]. Such delays may have significant consequences, in particular in term of endocrine deficit, neurologic impairment and increased risk of disseminated disease [2-4]. Therefore, the importance of the early diagnosis of GCT in patients is paramount.

Positron emission tomography (PET) has been shown to be a promising functional imaging modality in detecting a neoplastic processes, and evaluation of response to therapy [5]. Combining PET system with CT scan or MRI provides registered functional and anatomical images, which are of value in oncology [6]. Different PET tracers including ^{18}F -fluorodeoxyglucose (^{18}F -FDG), ^{11}C -methionine (MET), and ^{11}C -choline have been used in neuro-oncology for the evaluation of brain tumors such as glioma, and germinoma [3,7,8]. Few reports suggest using MET or ^{18}F -FDG PET in CNS germinoma.

We herein describe a 13-year-old female patient with a germinoma of the basal ganglia who presented with diabetes insipidus, headache, nausea and vomiting. MRI showed thickening of the pituitary stalk, but no definite abnormality was detected elsewhere. Further investigation with ^{18}F -FDG PET demonstrated asymmetric reduced activity in the basal ganglia, which was suggestive of germinoma. The possibility of suprasellar germinoma was further suspected on follow-up MRI that demonstrated progression of the lesion in the suprasellar region. An endoscopic biopsy was

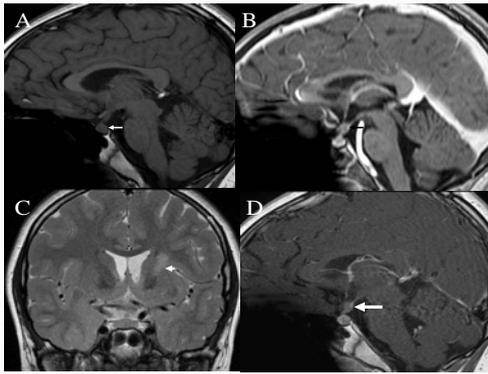


Figure 1: (A) Pre and (B) post contrast sagittal T1 weighted imaging at presentation demonstrate absent normal high T1 hyperintensity of the posterior pituitary gland and post contrast scan shows pituitary stalk thickening, but no definite abnormality in the basal ganglia (not shown). (C) contrast sagittal T2 and (D) post contrast T1 weighted imaging three months later demonstrate high T2 signal in the left basal ganglia and left anterior limb of internal capsule and further thickening of the pituitary stalk (arrow).

subsequently performed and confirmed the diagnosis.

Case Presentation

A 13-year-old female with one-year history of diabetes insipidus presented with nausea and vomiting, and right-sided headache migrating to the back. She did not have any complain of diplopia and her peripheral vision testing was normal. She reported a weight loss of 14 lbs during the last months as well as polydipsia, nocturia and hair loss. During her initial visit, neurologic examination including cranial nerves and cerebellar function were normal. She was at breast Tanner stage 2 and Pubic hair Tanner stage 3. A water deprivation test confirmed the diagnosis of diabetes insipidus. Serum alpha-fetoprotein was reported 1 microgram/L (normal range 1-4 microgram/L). Serum B-human chorionic gonadotropin (B-HCG) was reported <1 IU/L (normal range < 1.2 IU/L). Further investigation with MRI showed pituitary stalk thickening and absent normal T1 signal of the posterior pituitary gland with no definite abnormality in the basal ganglia (Figure 1A and B). CSF evaluation was negative for malignancy and tumor markers were negative in the CSF.

A PET scan with ^{18}F -FDG and skeletal survey were performed to assess for possible diagnosis of histiocytosis. No definite lytic lesion was detected on the skeletal survey. However, an asymmetric activity was detected in the basal ganglia without any extracranial abnormality (Figure 2). There was relative hypometabolism in the left basal ganglia with a maximum standardized uptake value (SUV_{max}) of 5.8 compared with the contralateral basal ganglia with an SUV_{max} of 9.1. The ipsilateral cerebral cortex also showed relatively decreased ^{18}F -FDG activity compared with the contralateral cerebral cortex. The PET finding was interpreted as suspicious for left basal ganglia tumoral involvement.

A repeat MRI after three months showed slight increase in the thickness of the pituitary stalk. The posterior pituitary bright spot remained absent. There was high T2/FLAIR signal in the superior aspect of the left basal ganglia and anterior limb of the internal capsule associated with a focus of enhancement and volume loss in the left basal ganglia suspicious for germinoma (Figure 1C and D). Following blood works didn't reveal any remarkable changes; alpha-feto protein was reported 2 micrograms/L (normal range 1-4 micrograms/L) and B-HCG was reported less than 1 IU/L (normal range < 1.2 IU/L).

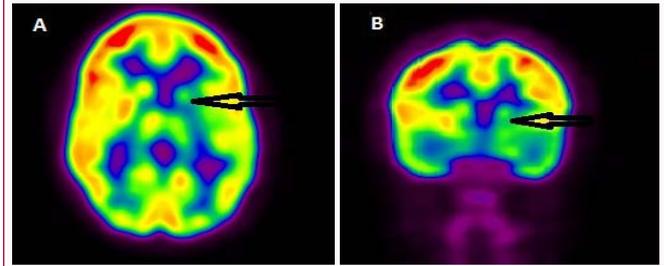


Figure 2: PET scan displayed in axial (A) and coronal (B) views showed asymmetric activity in the basal ganglia, as well as relative hypometabolism in the left basal ganglia. The ipsilateral cerebral cortex also showed relatively decreased ^{18}F -FDG activity compared with the contralateral cerebral cortex. The PET finding was interpreted as suspicious for left basal ganglia tumoral involvement.

CSF alpha feto protein was below 1 microgram/L and CSF B-HCG was reported less than 1 IU/L, both were insignificant upon hospital reference values. Ultimately, the diagnosis of suprasellar germinoma was confirmed by biopsy. The patient was treated with 4 courses of carboplatin-etoposide. Follow-up MRI after the end of chemotherapy showed significant improvement in pituitary stalk thickening, slight improvement in the abnormal signal in the superior aspect of the left basal ganglia and deep white matter. The patient eventually received whole brain radiation at a dose of 24 Gy in 13 sessions.

Discussion

Central nervous system GCTs are divided into germinomas (approximately 50%–70% of cases) and non-germinomatous germ cell tumors according to their clinicopathologic features [9]. These tumors are primarily seen in children accounting for 3-5% of pediatric brain tumors with a peak age of 10-12 years [9-12]. The most common primary tumor sites are the pineal region, the suprasellar area and the basal ganglia. Approximately, less than 14% of all intracranial GCTs occur in the basal ganglia or thalamus [13]. Initial symptoms are related to the tumor location. For suprasellar tumors, earliest symptoms usually involve endocrine dysfunction, most frequently diabetes insipidus and associating polyuria and polydipsia. Eventually other endocrine manifestations such as growth impairment or arrest, delayed or precocious puberty, hypothyroidism, and visual disturbances may occur as the tumor grows dorsally toward the optic chiasm. Patients with pineal tumor present with visual symptoms (parinaud syndrome) and signs and symptoms of increased intracranial pressure (ICP) [10,14]. Progressive hemiparesis is the most common presenting symptom of basal ganglia tumors. Patients diagnosed with suprasellar and basal ganglia germ cell tumors may have a long prodrome, up to several years in duration [1]. This is a report in which ^{18}F -FDG PET suggested tumoral involvement in the left basal ganglia before the MRI findings were visualized and may suggest a potential role for PET scan in early detection of suprasellar germinoma.

MRI is a sensitive imaging to identify suprasellar GCTs [12]. However, MRI cannot differentiate different types of GCTs and except in cases where characteristic serum and/or CSF tumor marker is elevated, biopsy is needed for definite diagnosis [12]. Both the clinical manifestations and MRI findings may progress for months before a definitive diagnosis is made. Several distinct MRI findings are described in the literature for basal ganglia germinoma, ranging from subtle non-enhancing patchy lesions to enhancing huge masses [15-17]. Phi et al. [17] classified these findings into four types. Type

Lesions show minimal or no enhancement, no mass effect and may be missed for long period of time or mistaken for benign lesions. Since the diagnosis is more delayed in this group, hemiparesis usually progress into profound motor deficit [17]. An imaging modality with the potential ability in early detection of GCTs is crucial to select the patients who need further investigation with biopsy. Functional imaging such as PET scan may play a role in this respect. Functional images may detect tumoral involvement weeks or months before any detectable structural abnormality is identified.

PET scan with ^{18}F -FDG, ^{11}C -MET, or ^{11}C -choline has been shown to be useful in detection of brain glioma and germinoma [3,7,8,18]. PET scan can be useful when there is a suspicious lesion on MRI but the biopsy cannot be performed because of the location of the lesion or because of other clinical conditions [19]. In our case ^{18}F -FDG PET showed hypometabolism in the involved basal ganglia as well as relatively decreased ^{18}F -FDG activity in the ipsilateral cerebral cortex compared with the contralateral cerebral cortex. The exact mechanism of reduced metabolic activity in the ipsilateral cerebral cortex is not clear. However, this finding has been described before [17]. A few reports are available describing ^{18}F -FDG PET findings in basal ganglia. In those studies, basal ganglia germinomas showed a relatively reduced ^{18}F -FDG activity compared to normal basal ganglia, regardless of the types of germinomas on MRI [17,20]. However, to our knowledge, there is no report describing the possibility for ^{18}F -FDG PET to suggest the diagnosis of basal ganglia germinoma before definitive findings appear on MRI. This is of pivotal importance in cases of suprasellar and basal ganglia germinoma in which the diagnosis may be delayed in spite of a thorough investigation. Since early diagnosis can prevent the disease from progression and have a commendable impact on the outcome, further evaluation with PET scan may be considered in specific clinical cases. Further prospective studies are needed to clarify the exact role of the PET scan compared to MRI in detecting all kinds of GCTs in the early stages of the disease.

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