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Case Report Open Access

Discrepancies of ^{11}C-MET Uptake and MRI Contrast Enhancement in a Glioblastoma: A PET/MRI Case Report

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Abstract

A 58-year-old female patient suffered from convulsion in the left upper limb and weakness in the left lower extremity for one month. In MR contrast-enhancing (CE) images, obvious rim-enhancement was only found in the frontal nodule, while fused ^{11}C-MET PET/MRI images showed increased MET uptake not only in the right frontal lesion but also in the body of corpus callosum. We postulated the discrepancy between MRI CE and MET uptake for the corpus callosum lesion maybe due to the following two reasons: firstly, a relative low malignant potential where absent of BBB disruption; secondly, the special affinity of MET to the oligodendroglioma. In addition, the ^{1}H-MRS, TDI and ASL data acquired simultaneously with PET scan indicated the frontal lesion had the features of typical malignant intracranial tumor. Finally, the pathological results confirmed the frontal lesion a WHO-IV grade glioblastoma with partial anaplasia oligodendroglioma. The imaging follow-up showed a newly abnormal CE in the body of corpus callosum, which was consistent with the previous increased MET uptake on PET/MRI examination. Our case indicates that one-stop multiparametric MET-PET/MRI has advantages for the management of intracranial tumor lesions by providing complementary information.

Keywords: Glioma; MRI; PET/MRI; MET; Oncology

Introduction

In the same way in which PET/CT has been shown to be a powerful multimodality imaging tool, PET/MRI could have the following advantages: improved soft-tissue contrast; the possibility of performing truly simultaneous instead of sequential acquisitions; and the availability of sophisticated MRI sequences, such as diffusion and perfusion imaging and MR spectroscopy (MRS), which made PET/MRI is perfectly suitable for neurologic imaging [1,2]. In addition, it is well known that in most brain tumors uptake of amino acids (AA) is elevated, which is probably due to increased carrier-mediated transport at the blood-brain barrier (BBB), rather than to gross BBB breakdown or increased incorporation of AA into tumor issue. Thus increased uptake is also seen in most low-grade gliomas in the absence of BBB damage; this is a substantial advantage of PET with amino acids over contrast-enhancing CT, MRI and ^{18}F-FDG [3-5]. In this case report, we presented a case of ^{11}C-MET PET/MRI for glioblastoma, which showed the discrepancy between MET uptake and MRI contrast enhancement (CE).

Case Report

A 58-year-old Chinese female patient has a history of convulsion in the left upper limb and weakness in the left lower extremity for one month. Physical examination indicated the muscle strength deceased to III grade with cutaneous hypoesthesia. In her routine blood test and tumor marker screen, no remarkable abnormalities were reported (Figure 1). In her first MRI scan, a white matter nodule with hypointense on T1 weighted imaging (T1WI) and heterogenous hyperintense on T2-weighted image with fluid attenuation inversion recovery (T2-FLAIR) images in the right frontal lobe was detected. In addition, diffuse abnormal signal was also observed in the white matter beside the right lateral ventricle and the body of corpus callosum on T1W and T2W structure images. After Gd-DTPA based contrast agent was administrated, the obvious rim-enhancement of the frontal nodule was detected (Figure 1c).

Prior to a surgical resection of the intracranial lesion, a carbon eleven labeled methionine positron emission tomography/magnetic resonance imaging was (^{11}C-MET PET/MRI) was suggested for the purpose of accurate diagnosis. The scan was performed on an integrated PET/MRI system (Biograph mMR, Siemens Healthcare, Erlangen, Germany) at 15 minutes after intravenous injection of 8.9mCi (329MBq) of ^{11}C-MET and covered the whole brain. The PET data were acquired with the duration of 10 minutes and its attenuation correction was done with the build-in Ultrashort echo-time sequence, as described [2]. The MRI scanning was performed simultaneously with PET imaging with the following sequence protocol: Sagital 3D-T1-magnetization prepared rapid gradient echo (3D-T1-mprage); transverse T2-FLAIR; transverse diffusion tracking density imaging (TDI) sequence; single voxel ^{1}H-MRS and artery spin label (ASL). No MRI contrast agent was administered. Although diffuse abnormal signal was found in a relative diffused regions, the obvious MET uptake were only observed in the lesions located at right frontal lobe and the corpus callosum with the SUVmax up to 2.76 and 2.08, respectively (Figures 1a and 1b). MRS and ASL results indicated the frontal lesion had a typical spectrum of malignant brain tumor with hyperperfusion (Figures 2a and 2b). TDI showed the decreased fiber density in the corpus callosum lesion (Figure 2c). Based on the complementary information from the multiparametric imaging, a malignant glioma was considered from MET-PET/MR examination, and the lesion in the

body of corpus callosum with the feature of increased MET uptake, lack of contrast enhancement (CE) and decreased fiber density might particularly be taken more attention for clinical treatment. After tumor resection, the clinical symptoms disappeared and the pathological results confirmed the frontal lesion a WHO-IV grade glioblastoma with partial anaplasia oligodendroglioma (Figure 3). In the follow-up MRI scan which was 7 months after surgery, a newly abnormal CE was found in the body of corpus callosum, which was consistent with the previous increased MET uptake and decreased fiber density on PET/MRI examination (Figure 4).

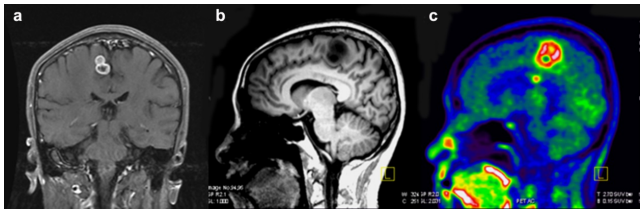

Figure 1: (a) Coronal CE T1WI shows the right frontal lesion has the obvious irregular rim enhancement. (b) Sagital 3D-T1-mprage image shows the heterogenous hypointensity in the frontal lobe and the body of corpus callosum with (c) increased MET uptake (SUV_{max} up to 2.76 and 2.08, respectively).

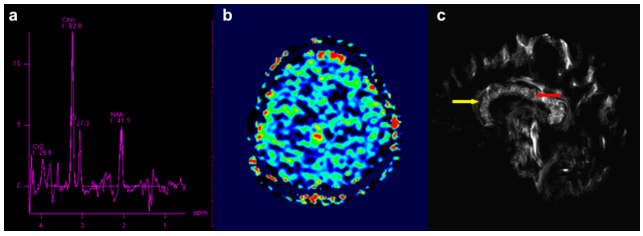

Figure 2: Multiparametric images from integrated PET/MRI system. (a) Single-voxel MRS shows decreased NAA and elevated choline, which indicates a primary intracranial neoplasm. (b) 2D-ASL indicates the hyperperfusion of the frontal lesion. (c) The track density imaging (TDI) showing the white matter fiber in the body of corpus callosum was disrupted by the tumor infiltration with decreased relative track density (red arrow, 4.4) than the normal region of the genu of corpus callosum (yellow arrow, 10.7).

Discussion

^{11}C-MET has been widely used for brain tumor imaging, which uptake is greater in high-grade than in low-grade gliomas and also correlates with prognosis and survival rate [3,6-8]. It is reported that the spatial extent of increased MET uptake can be larger than that of MR CE in glioma, which may include not only solid tumor but also the surrounding zone of tumor infiltration [9,10]. In this case, the lesion located in the body of corpus callosum was observed mild MET uptake in the absence of CE. We postulated this discrepancy between two modality imagings may be due to the lesion had a biological feature of lower potential malignancy, where BBB was relatively intact. In addition, MET uptake in brain tumors has a special phenomenon, which is its uptake differed with tumor type: in oligodendrogliomas uptake tends to be higher than in astrocytomas of the same histological grade, although they are clinically somewhat less aggressive than the latter [3,6,11]. Considering the partial anaplasia oligodendroglioma detected in the final specimen, we postulates the discrepancy might also due to the special affinity of MET to the oligodendroglioma. It is noted that the lesion in the body of corpus callosum was illustrated moderate CE in the seven moths after tumor resection, which probably indicates a tumor progression.

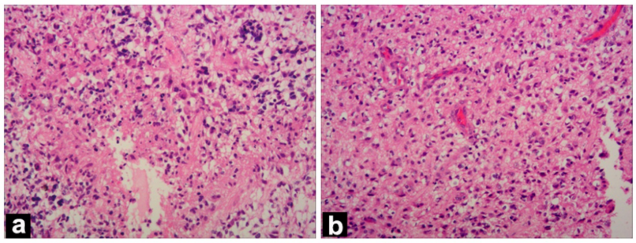

Figure 3: Histopathological images of the right frontal lesion: (a) Necrosis and microvascular proliferation of glioblastoma. (Stain: hematoxylin-eosin; original magnification: X200). (b) Cellular and diffusely infiltration of tumor cells with rounded hyperchromatic nuclei, perinuclear halos. (Stain: hematoxylin-eosin; original magnification: X200).

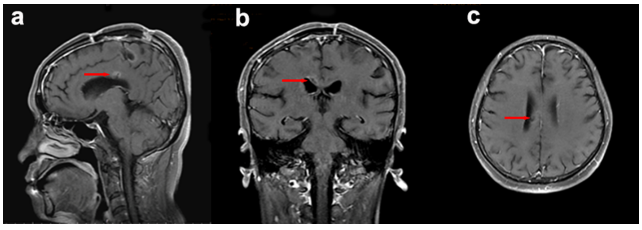

Figure 4: Three sectional T1WI contrast images at seven months after surgery, moderate CE in the body of corpus callosum was observed, which might indicate a tumor progression.

Hybrid PET/MRI system can provide morphological and biochemical/metabolic information. In combination of PET, at the base of structural MRI sequences, advanced MRI techniques including TDI, MRS and ASL sequences were employed to provide the multiparametric biological features of the brain tumor, including the microstructure of white matter, metabolism and regional blood flow. The complementary imaging information from one-stop MET-PET/MRI scan increased the diagnostic accuracy. Particularly, the discrepancy between MET uptake and MR CE may arouse the clinical attention but only for the determination of tumor extent for tumor resection but the prognosis and choice of following treatment, which emphasized advantages of integrated PET/MR images for the management of intracranial tumor lesions.

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