

LETTER / *Neuroradiology*

Diffuse cortical hypermetabolism of the cerebellum in meningeal carcinomatosis: Assessment with ^{18}F -FDG-PET/CT and MRI



Keywords Positron emission tomography-computed tomography (PET/CT); Central nervous system neoplasms; Lung adenocarcinoma; Neuroimaging; FLAIR imaging

Dear Editor,

Cerebellar cortex hypermetabolism is an extremely rare condition [1], without clear magnetic resonance imaging (MRI) correlation. We report a rapidly progressive meningeal carcinomatosis, which was diagnosed with ^{18}F -fluorodeoxyglucose positron emission/computed tomography (^{18}F -FDG-PET/CT) and further confirmed with MRI and lumbar puncture.

A 61-year-old man was initially treated by surgery and radiotherapy 8 years ago for an invasive mucinous adenocarcinoma of the lung. During the follow-up, the patient developed diffuse metastases, which were successively treated by docetaxel, nivolumab and gemcitabine. In March 2018, a cerebellar metastasis was treated using Cyber-knife® and a new line of chemotherapy combining paclitaxel and bevacizumab. Two months later, ^{18}F -FDG-PET/CT demonstrated partial metabolic response. No brain metastatic relapse was seen on MRI. Four months later, the patient reported intense posterior headaches, fatigue, chest pain and vomiting. Clinical examination revealed dysarthria but no cerebellar syndrome, other cranial nerve deficit or intracranial hypertension. ^{18}F -FDG-PET/CT showed intense, diffuse, bilateral, cortical hypermetabolism that exclusively involved the cerebellum with a maximal standardized uptake value (SUVmax) of 15.4 (Fig. 1). Moreover, all target lesions demonstrated an increase in size and SUVmax. MRI of the brain (1.5 T, Magnetom Aera®, Siemens-Healthineers) including fat-saturated two-dimensional (2D) FLAIR, diffusion-weighted and gadolinium-chelate enhanced T1-weighted three-dimensional (3D) gradient-echo imaging showed no newly developed lesions. However, contrast-enhanced T1-weighted 3D turbo-spin-echo with magnetization transfer and fat suppression (using spectral attenuated inversion recovery technique) demonstrated subtle, linear, leptomeningeal enhancement of the cortical sulci of the cerebellar hemispheres (Fig. 2). In addition, fat-saturated 2D FLAIR images obtained 15 min after intravenous administration of gadolinium chelate disclosed marked enhancement of the lepto- and pachymeningeal spaces that predominated in the posterior fossa but were also seen

around all lobes. Analysis of cerebrospinal fluid after lumbar puncture confirmed meningeal carcinomatosis with multiple tumor cells in conjunction with normal glucose concentration (1.26 mmol/L), slightly increased protein concentration (0.44 g/L, norm: <0.40 g/L), 2 red cells per mm³, mildly increased number of white cells (23/mm³) and no germs. Despite corticosteroids and a new line of treatment by vinorelbine, the symptoms worsened and the patient died 8 days later.

High ^{18}F -FDG avidity during meningeal carcinomatosis can involve meningeal metastases and/or adjacent cortex [2]. Herein, the main differential diagnosis was paraneoplastic cerebellar degeneration (PCD). ^{18}F -FDG-PET/CT in patients with PCD can show a global decrease in cerebellar uptake with atrophy, or diffuse hypermetabolism of the cerebellar cortex or be normal in most patients [1,3]. However, the acute clinical presentation and the unfavorable outcome after steroids were not consistent with PCD. Because of the similarity of the imaging presentations of some patients with PCD and others with meningeal carcinomatosis [4], it could be hypothesized that a similar cerebellar inflammation could occur during the two conditions. The superiority of contrast-enhanced T1-weighted 3D turbo spin-echo and contrast-enhanced 2D FLAIR imaging over contrast-enhanced T1-weighted 3D gradient echo imaging has already been recognized, contrast-enhanced 2D FLAIR performing best in the posterior fossa [5]. We did not perform contrast-enhanced 3D FLAIR, but, since this sequence suppresses flow artifact and decreases the partial volume effect between small leptomeningeal lesions and normal tissues, it may increase the depiction of leptomeningeal metastases compared with 2D FLAIR. The FLAIR sequence generates mildly T1-weighted images, leading to contrast enhancement of lesions with low gadolinium-chelate uptake. This is the case for meningeal metastases during delayed acquisition. The delay allows an increase in gadolinium-chelate concentration in the cerebrospinal fluid. Herein, contrast-enhanced 2D FLAIR was the most delayed acquisition, thus explaining its highest diagnostic performance. A standard protocol (i.e., ^{18}F -FDG-PET/CT on chest-abdomen-pelvis and brain MRI with contrast-enhanced T1-weighted 3D gradient echo imaging) would have failed to reveal meningeal dissemination of the disease.

Human and animal rights

The authors declare that the work described has been carried out in accordance with the Declaration of Helsinki of the Medical Association revised in 2013 for experiments involving humans.

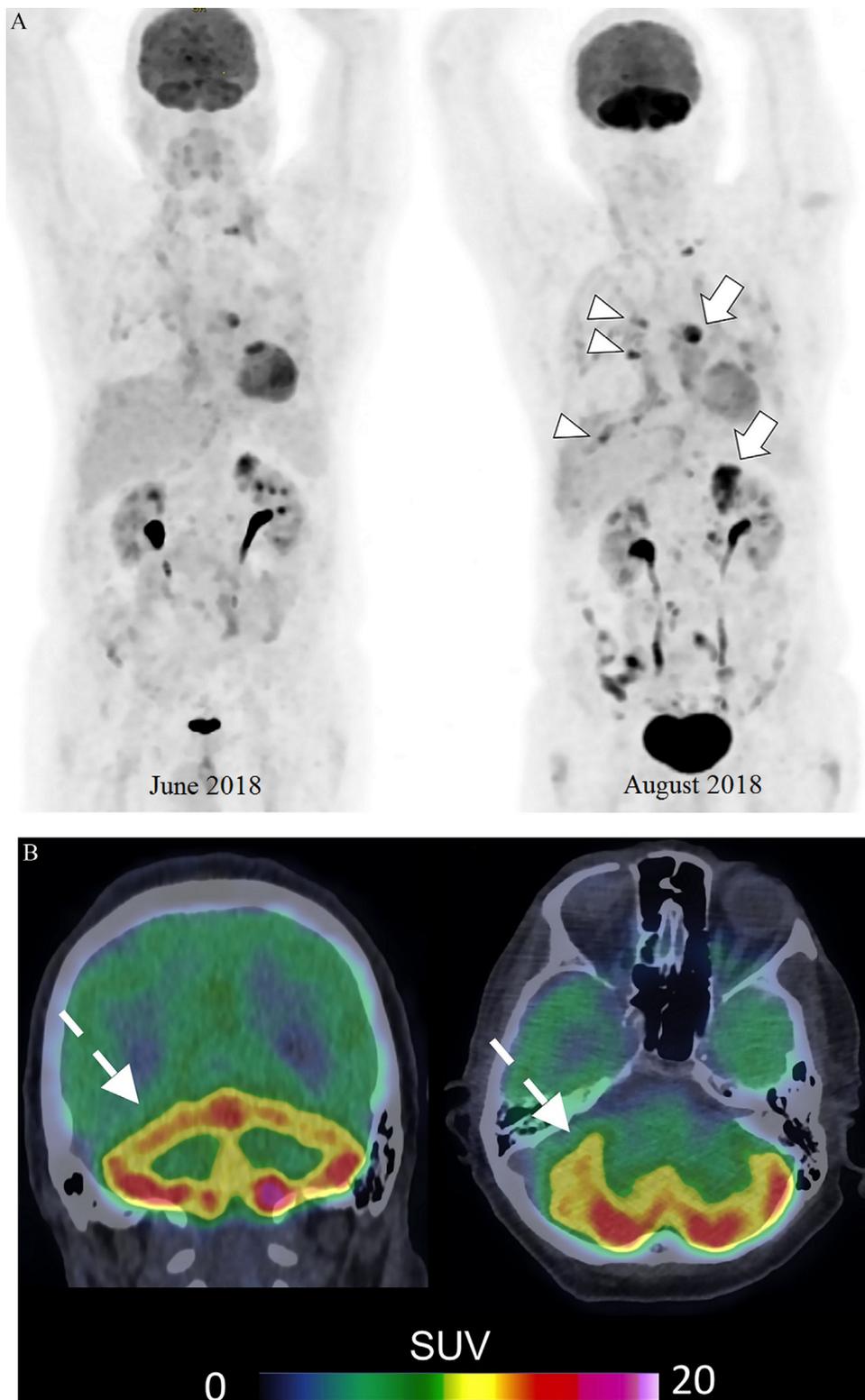


Figure 1. A 61-year-old-man presented with metastatic lung adenocarcinoma presenting with a intense cerebellar metabolism revealing meningeal carcinomatosis. (A) ^{18}F -Fluorodeoxyglucose positron emission tomography at the nadir of the last chemotherapy (June 2018) and at the final response evaluation (August 2018). Maximum intensity projection reformations show newly developed peritoneal and mediastinal lymph node metastases (arrowheads) and an increase in size and standardized uptake values (SUV) of pre-existing adrenal and lymph node metastases (arrows). (B) There is a strong increase in the SUV of the cerebellar cortex, involving the 2 hemispheres and the vermis (dashed arrows).

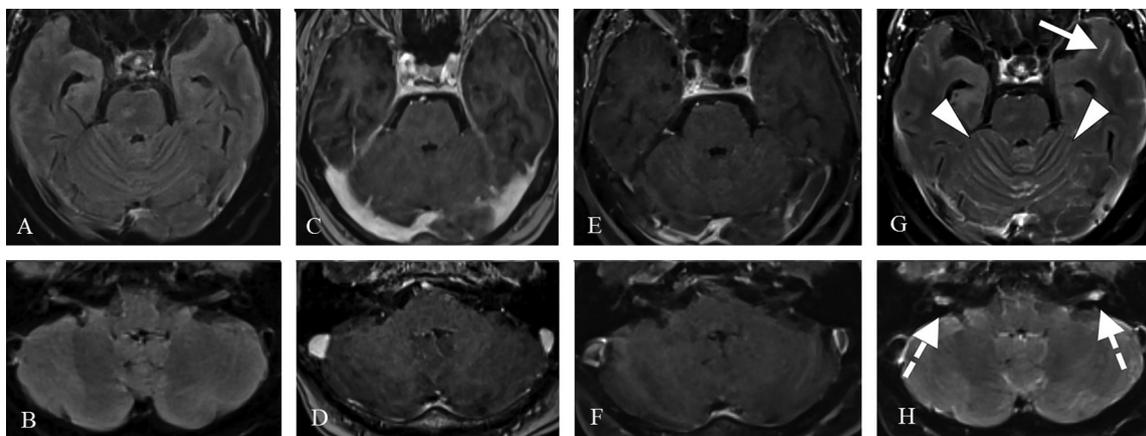


Figure 2. Comparison of MR sequences in their capabilities in detecting meningeal carcinomatosis. (A, B) Fat-saturated 2D FLAIR turbo spin-echo images in the axial plane (TR/TE/TI=6500/123/2120 msec; slice thickness = 4 mm) show no lesions. (C, D), T1-weighted 3D gradient-echo images in the axial plane (TR/TE/TI = 2200/3.09/900 msec; slice thickness = 1 mm) obtained 4 min after intravenous administration of a gadolinium-chelate show no definite meningeal or brain abnormalities. (E, F), T1-weighted 3D turbo spin-echo images in the axial plane (SPACE sequence; TR/TE = 600/16msec; slice thickness = 1.1 mm) obtained 9 min after intravenous administration of a gadolinium-chelate show no meningeal or brain abnormalities. (G, H), Fat-saturated 2D FLAIR turbo spin-echo images in the axial plane (TR/TE/TI = 6500/123/2120 msec; slice thickness = 4 mm) obtained 15 min after intravenous administration of a gadolinium-chelate demonstrates multiple linear areas of enhancement of the leptomeningeal and pachymeningeal spaces, which are predominantly located in the posterior fossa (arrowheads) but are also present at the supratentorial level (arrows) and surround the right and left 7th and 8th cranial nerves (dashed arrows).

Informed consent and patient details

The authors declare that this report does not contain any personal information that could lead to the identification of the patient(s).

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Author contributions

All authors attest that they meet the current International Committee of Medical Journal Editors (ICMJE) criteria for authorship.

Disclosure of Interest

The authors declare that they have no competing interest.

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