Intracranial Leptomeningeal Carcinomatosis in Three Cases from Breast Cancer Demonstrated on F-18 Fluorodeoxyglucose Positron Emission Tomography/Computerized Tomography

Hulya Ortapamuk, Mustafa Kemal Demir[1]

Departments of Nuclear Medicine and [1]Radiology, School of Medicine, Bahcesehir University, Istanbul, Turkey

Abstract

Leptomeningeal carcinomatosis (LC) is an uncommon late manifestation of non-central nervous system (CNS) solid tumors. With prolonged survival in solid tumors, an increased frequency of metastases is noted in these tumors too. The detection of tumor cells in the cerebrospinal fluid remains the gold standard. Noninvasively, magnetic resonance imaging is frequently used for the diagnosis of LC. Although its low sensitivity of F-18 fluorodeoxyglucose positron emission tomography/computerized tomography (F-18 FDG PET/CT) on demonstrating CNS lesions, it could be useful in identifying the possibility of LC of breast carcinoma by giving high attention to the meninges. We discuss here three cases all of them having intracranial LC; where ^{18}F-FDG PET/CT study helped us in the diagnosis of LC. To our knowledge, this is the second report about intracranial LC from breast cancer demonstrating on ^{18}F-FDG PET/CT.

Keywords: *Breast cancer, F-18 fluorodeoxyglucose positron emission tomography/computerized tomography, leptomeningeal carcinomatosis*

Introduction

Leptomeningeal carcinomatosis (LC) is characterized by invasion of leptomeninges and subarachnoid space by neoplastic cells and frequently with a poor prognosis. Although its treatment is palliative, the earlier diagnosis will lead to prolonged survival and improve functional outcome.[1,2] It occurs in approximately 2–5% of patients with breast cancer and most of them have intraparenchymal brain metastases concurrent with LC.[3] The most common and definitive method for LC diagnosis is the detection of metastatic cells in cerebrospinal fluid (CSF); the first lumbar puncture reveals positive cytology in only up to 50% of patients, and the yield increases to 90% only after three lumbar punctures. Contrast-enhanced magnetic resonance imaging (MRI) is useful for diagnosis of LC.[1,4] We present three cases of LC from breast cancer in which ^{18}F-fluorodeoxyglucose positron emission tomography (^{18}F-FDG PET) scan revealed abnormal FDG uptake on intracranial leptomeninges suggesting LC that were confirmed by MRI.

Case Reports

Case 1

A 25-year-old woman with left breast cancer underwent a modified radical mastectomy with axillary dissection followed by six cycles of chemotherapy and local radiotherapy to the chest. She was admitted because of a headache 1 year later. The contrast-enhanced brain MRI was performed, and it revealed that abnormal hyperintense signal and nodular thickness on the surface of the bilateral cerebral and cerebellar hemispheres, suggestive of LC [Figure 1a]. She was referred for F-18 FDG PET/computerized tomography (CT) study to identify if there were any other metastases. PET/CT images showed increased abnormal FDG accumulations on both cerebellar and cerebral hemispheres surfaces with highly suspicious for LC [Figure 1b and c]; multiple bone metastases involving vertebral column, sternum, iliac bones were also shown.

Case 2

A 47-year-old woman with a history of left breast carcinoma had been underwent

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Address for correspondence:
Prof. Hulya Ortapamuk, Department of Nuclear Medicine, School of Medicine, Bahcesehir University, Goztepe Medical Park Hospital, Istanbul, Turkey.
E-mail: hortapamuk@yahoo.com

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mastectomy, subsequent chemotherapy, and locoregional radiotherapy 2 years ago. She was complaining of generalize pain, fatigue for 1 month. F-18 FDG PET/CT performed to evaluate for recurrent disease if any. Whole body F-18 FDG PET showed bone metastases; additionally increased focal FDG accumulations on the right and left cerebral surface area which was highly suspicious for dural metastases [Figure 2b]. Contrast-enhanced MRI was requested, in which dural heterogen density and focal nodularity with increase contrast fixation suggestive of LC [Figure 2a].

Case 3

A 46-year-old woman was admitted to our hospital due to a headache and ataxia for 2 weeks. Cranial MRI demonstrated contrast-enhancement on posterior fossa, bilaterally base of temporal lobes suggesting leptomeningeal metastases and 20 cm × 38 cm mass at left temporal lobe [Figure 3a]. Excisional biopsy of the left temporal mass showed metastatic cells and CSF aspiration showed malignant cells on the CSF. She was referred to F-18 FDG PET/CT for investigation of the primary tumor. PET/CT demonstrated increased FDG uptake on the surface of left temporal lobe, both cerebral hemispheres; also a hypermetabolic mass on lower quadrant of left breast [Figure 3b and c]. Biopsy of the breast mass showed intraductal breast cancer.

Discussion

Meningeal carcinomatosis is a fatal complication of breast cancer that affects 5–8% of patients. The incidences of meningeal metastases increase with prolonged lifespan resulting from treatment advances for primary breast cancer and their metastases.[5] Traditionally, LC occurs in late stages of the disease by hematogenous spread or invasion of brain metastases. It results severe neurological complications involving the cranial nerves, cerebrum, and spinal cord limiting life expectancy to <4 months. The clinical signs and symptoms are highly variable; diagnosis can be difficult. Treatment is currently palliative; in untreated patients expected median survival is <4 weeks.[6,7] CSF cytological analysis is the gold standard for diagnosis. In symptomatic patients, contrast-enhanced MRI scan is the noninvasive diagnostic modality of choice. Enhancement of the metastatic lesion is dramatic as even small nodular metastases enhance strongly and are easily detected on postcontrast images.[1,3]

Many patients who could potentially have spinal LC undergo ^{18}F-FDG PET/CT. Recent case reports have documented both intracranial and extracranial LC on ^{18}F-FDG PET/CT.[8-11] FDG PET/CT can occasionally pick up LC if careful attention is paid to patterns of LM spread. Multiple factors may explain the observed low sensitivity of ^{18}F-FDG PET/CT for detecting LC. Small volumes of tumor may not accumulate sufficient FDG to generate a discernable signal, the spatial resolution of PET is intrinsically limited by the nature of positron annihilation events and PET instrumentation factors, and small metastatic foci adjacent to cerebral cortex may be inconspicuous because of high cortical FDG uptake. Chemotherapy and steroid therapy also have been shown to lower the efficacy of ^{18}F-FDG PET/CT in detecting malignancy and may lead to false-negative results.[12]

In literature, a few cases of F-18 FDG PET/CT detection of spinal LC from breast cancer and only one case was reported having intracranial LC from breast cancer detected with F-18 FDG PET/CT.[13,14] In our all three cases, LC was demonstrated by F-18 FDG PET. In our knowledge, this is the second report of intracranial LC from breast cancer detected with F-18 FDG PET/CT in literature. The increase of cases with LC demonstrated on PET/CT; is not only by giving more pay attention to the leptomeningeal areas with increasing PET reader skills and also advances of PET/CT devices; there has been a considerable improvement in the sensitivity of the images may result detection of these type

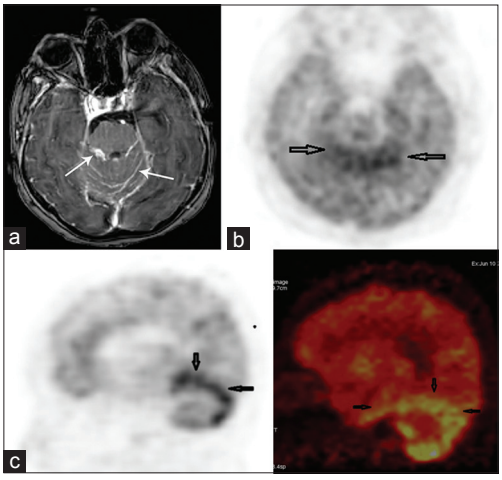

Figure 1: (a) MRI image shows focal nodular enhancement and thickening on cerebellar follia (arrows). Transaxial (b) and sagittal (c) images of PET, and transaxial PET/CT fusion images obtained 60 min after an intravenous injection of 370 MBq of ^{18}F-FDG shows increased focal FDG accumulation on the surface of both cerebellar and cerebral hemispheres (arrows). F-18 FDG PET/CT: F-18 fluorodeoxyglucose positron emission tomography/computerized tomography, MRI: Magnetic resonance imaging

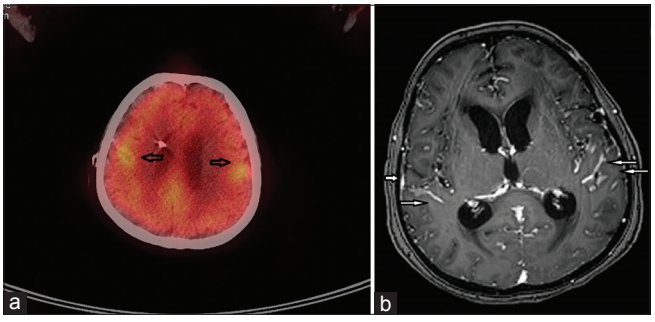

Figure 2: (a) Contrast axial images of MRI showing dural thickness and nodularities with contrast fixation of right and left cerebral leptomeninges (arrows). Transaxial (b) Transaxial images of 18F - FDG PET showing increases lepromeningeal FDG uptake on the right and left cerebral hemisphers (arrows)

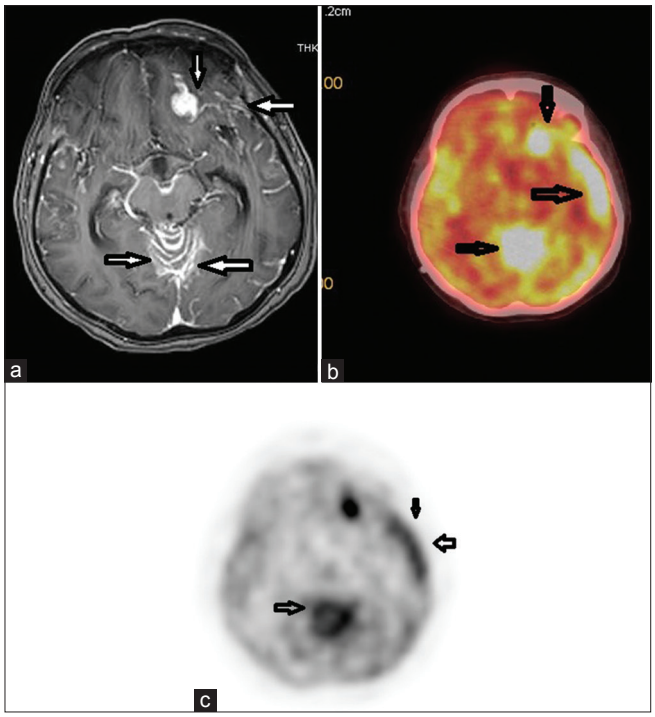

Figure 3: (a) MRI showing leptomeningeal opacification on posterior cranial fossa, convexite, bilateral temporal lobes surface and intraparencyhmal mass on left frontobazal. Axial (b) slice of PET/CT and axial fusion image (c) demonstrating abnormal FDG uptake on the both surfaces of the cerebellar hemispheres, left temporal lobe, and intraparancymeal mass. F-18 FDG PET/CT: F-18 fluorodeoxyglucose positron emission tomography/computerized tomography, MRI: Magnetic resonance imaging

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Conflicts of interest

There are no conflicts of interest.

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