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Utilization of Fluoroestradiol F-18 PET/CT in Combination with MRI for Management of ER+ Brain Metastases

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Abstract

Objectives:

Accurate detection and evaluation of brain metastases (BrMs) are critical for effective management and treatment. While MRI is the standard imaging modality for BrMs, they can be difficult to delineate or characterize at times based on their size and/or location especially when prior treatments such as radiation therapy (RT), surgery, or systemic therapy have been given. [18F]-fluoroestradiol (18F-FES) PET imaging can be utilized in scenarios where there is clinical uncertainty based on MRI. A 18F-FES PET/CT has proven to be useful in detecting metastatic lesions with estrogen receptor positivity (ER+). In theory, this can assist in differentiating between radiation necrosis vs progressive tumor and evaluate the extent of CNS disease in patients with estrogen receptor positive (ER+) BrMs. Additionally, 18F-FES PET/CT may be useful in evaluating lesions that are subcentimetric in size with improved sensitivity and specificity. This study aims to assess the utility of 18F-FES PET/CT fused with MRI in detecting BrMs and informing management decisions. By comparing MRI alone with combined 18F-FES PET/CT and MRI imaging, we explored whether radiographic discrepancies between these imaging modalities impacted treatment planning for patients with brain metastases.

Methods:

Following IRB approval, we conducted a retrospective study on patients with a history of ER+ breast cancer and metastatic brain lesions who had acquired an 18F-FES PET/CT in 2023-2024. All patients underwent MRI brain with and without contrast and 18F-FES PET/CT imaging if there was uncertainty regarding intraparenchymal lesions. It was utilized to evaluate radiation necrosis vs progressive tumor or to evaluate extent of CNS disease. Baseline characteristics were obtained in the patient cohort including patient age, sex, luminal type breast cancer, and HER2 status. The PET/CT scans were fused with MRI and each metastatic brain lesion was reviewed. Discrepancies between MRI and 18F-FES PET/CT findings were documented with respect to each lesion, and their impact on clinical decision making was analyzed. Each case was reviewed by a multidisciplinary team to determine whether the additional information from 18F-FES PET/CT influenced changes in treatment management including further radiation therapy/systemic therapy or continued surveillance strategies.

Results:

A total of 8 patients with 53 BrMs, which included both previously treated and newly identified lesions, were included. The mean age at which 18F-FES PET/CT was acquired was 66.1 (SD, 7.74) years old. All patients were female with 6 patients having luminal type A breast cancer and 3 patients with HER2+ disease. 18F-FES PET/CT was utilized to distinguish between tumor recurrence vs radiation necrosis in 6 patients and 14 lesions. Of these lesions, 4 were identified as likely representing residual/recurrent tumor which were treated with a repeat course of radiation or initiation of systemic therapy with improved radiographic post-treatment imaging. For cases where treatment effect was suggested, 7 lesions demonstrated resolution on subsequent MRI, correlating with clinical stability. Two patients had PET ordered to evaluate the extent of disease. One patient had clinical uncertainty between metastatic breast cancer vs meningioma based on MRI brain which were confirmed to be non-avid on 18F-FES PET/CT. The second patient had a history of whole brain RT for BrMs and was noted to have 30 subcentimetric lesions – 27 enhancing lesions noted on MRI, only 14 (52%) of which were PET-avid, and 3 PET-avid lesions which were not noted on MRI. Out of the 53

BrMs, MRI alone failed to identify 5 lesions that were subsequently detected by 18F-FES PET/CT. Following acquisition of 18F-FES PET/CT there was a modification in the management approach for 7 out of the 8 patients (88%). Specifically, changes included adjustments in radiotherapy treatment planning, altered systemic therapy plans, and/or continued surveillance.

Conclusion(s):

Our findings suggest that 18F-FES PET/CT fused with MRI offers valuable diagnostic advantages over MRI alone for both detection of BrMs and for clarification between residual tumor vs post-treatment changes. The results underscore the increased sensitivity and specificity of 18F-FES PET/CT for detecting smaller or less distinct lesions. This combined imaging approach not only enhances lesion detection, but also provides critical information that can impact clinical decision making, particularly in complex cases where MRI results are inconclusive. Incorporating 18F-FES PET/CT into routine imaging protocols for patients with ER+ BrMs may provide improved treatment planning and management. Further research with larger patient cohorts is warranted to confirm these results and further refine the role of 18F-FES PET/CT in the multidisciplinary management of brain metastases.