18-FDG PET/MRI Performs Comparably to 18-FDG PET/CT and better than MRI in Metastatic Breast Cancer

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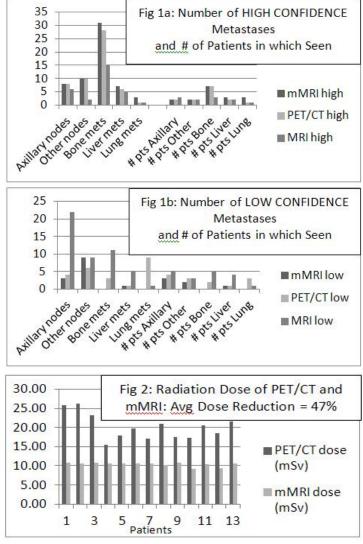
Audience: Radiologists and basic scientists interested in methods and multi-organ system performance of 18-FDGPET/MRI for breast cancer.

Purpose: Staging and surveillance of metastatic breast cancer often involves serial 18FDG-PET/CT studies. Reported limitations include relatively low sensitivity for some bone metastases, obscuration of brain and liver lesions due to high local physiologic uptake (1,2) and a lifetime attributable risk of radiation induced cancer per scan of 2-5/1000 in young American women (3). MR imaging involves no ionizing radiation and has shown to be effective for staging and monitoring distant metastases (4-7). However, MRI is limited by inferior detection of nodal disease when compared to PET/CT (7). The recent advent of a molecularMR (mMR) machine presents the unique opportunity to fuse the advantages of MRI and PET without the radiation of CT. We compared PET/MRI to PET/CT and whole body (WB) MRI alone in the evaluation of multi-organ metastatic breast cancer in terms of: 1) lesion detection, 2) reader confidence, and 3) radiation dose.

Methods: For this HIPAA compliant, IRB approved prospective study, 13 women (age 39-77, mean 58) with n=1 newly diagnosed T2 or n=12 history of metastatic breast cancer underwent WB simultaneous 18-FDG-PET/MR imaging on a commercially available integrated 3T PET/MR scanner (Siemens Biograph mMR) 90-120 minutes after 18-FDG injection for their routine clinical PET/CT.

Fig 1a: Number of HIGH CONFIDENCE Metastases and # of Patients in which Seen

Fig 1b: Number of LOW CONFIDENCE Metastases and # of Patients in which Seen

Fig 2: Radiation Dose of PET/CT and mMRI: Avg Dose Reduction = 47%

Following WB gradient echo scout, a WB exam was conducted including 6-7 stations from thighs to vertex, with the following protocols per station: (1) 3D coronal VIBE Dixon for PET attenuation correction (AC), (2) prototype T1 weighted radial 3D gradient echo (radial VIBE) and (3) 2D double-refocused echo-planar, diffusion weighted imaging (TR/TE =6000 / 65 ms, FOV 450 mm, 2.3x2.3x6mm voxel, SPAIR fat-suppression, three diffusion directions (3-scan trace) and b-values 0, 350, and 700 s/mm^2). MR images were acquired prone with a set of flexible body matrix coils after or without (n=1) rapid bolus injection of 0.1 mmol/L of gadopentetate dimeglumine (Magnevist, Bayer)/kg body weight at 2.0 mL/sec IV prior to the first station. PET events were simultaneously accumulated for 6 min per station and images were reconstructed on the vendor platform incorporating u-maps from the AC scan. Images were read from PACS (iSite, Philips) and PET/MRI images were read from Mirada-64 (Mirada), each by one radiologist with 1-4 years experience in their modality. Number of suspected metastases per organ system, reader confidence (low or high), incidentalomas and radiation dose (DLP conversion for CT(8) and mCi conversion for PET(9)), were recorded and analyzed.

Results: Figure 1 summarizes number of high and low confidence metastases per organ and number of patients in which they are seen for mMRI, PET/CT and MRI alone. Molecular MRI detected all high confidence lesions seen on PET/CT and MRI alone with the exception of a single axillary node counted on MRI alone. As compared with PET/CT, one additional suspicious liver lesion was a falsely positive hemangioma on dedicated imaging. Two lung metastases were better seen on mMRI than PET/CT. MRI alone was less sensitive for high confidence metastases in all organ systems. Molecular MRI detected fewer low confidence lesions in all organ systems as compared with PET/CT and MRI. mMRI detected fewer indeterminate lung nodules than PET/CT. mMRI and MRI alone detected more incidentalomas (23 each) than PET/CT (3); however information was sufficient not to order additional tests in all but 1 mMRI and 2 MRI alone. Figure 2 demostrates radiation dose reduction averages 47% with mMR as compared with PET/CT.

Discussion: PET/MR imaging of metastatic breast cancer is feasible and performs comparably to PET/CT and better than MRI alone for detection of findings highly suspicious for metastasis at about half the radiation dose of PET/CT. Lower numbers of low confidence findings seen on PET/MRI as compared with MRI suggests added PET provides increased specificity.

Conclusion: 18FDG-PET/MRI may provide improved performance over currently available WB examinations for breast cancer.

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