

Breast PET/MRI correlations between SUVmax, ADCmin, tumor markers and systemic disease

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Target Audience: Clinician- and basic- scientists interested in PET/MRI applications for localized breast cancers.

Background: Dynamic contrast enhanced (DCE) MRI is commonly used to determine the local extent of a newly diagnosed breast cancer and to assess for contralateral disease. Although DCE breast MRI is highly sensitive, it has been shown to overestimate disease extent, thereby causing patients to undergo more extensive surgeries including mastectomies, when breast conservation would have been adequate. Fusion of PET data with MRI images has been shown to increase the specificity of DCE breast MRI, as has the addition of diffusion-weighted imaging (DWI). At present, PET and DWI are not routinely acquired and evaluated together with DCE breast MRI sequences in clinical practice.

The recent development of an integrated PET/MRI machine allows simultaneous acquisition of PET and MRI data, which may improve DCE MRI specificity and facilitate correlation between local imaging metrics and histologic markers. Our aim, therefore, was to 1) compare tumor size on PET and DWI to T1 post-contrast images, and 2) investigate whether SUV and DWI metrics correlate with each other and with histologic breast cancer markers and could serve as biomarkers.

Methods: For this HIPPA compliant, IRB approved study, 15 patients with an in-situ breast cancer underwent breast PET/MRI. MRI and PET images of the breast were simultaneously acquired on a whole-body integrated 3T MR/PET scanner (Siemens Biograph mMR) in the prone position with a dedicated 4-channel breast coil (Noras, Würzburg, Germany) following routine PET/CT without additional FDG injection. Contrast-enhanced MRI was acquired with either a standard Cartesian 3D VIBE sequence or a prototype radial VIBE sequence. Diffusion-weighted images were collected with a twice-refocused spin echo sequence with echo planar readout with SPAIR and extra fat suppression and dynamic distortion correction, using b-values of b= 0,30,70,100,150,200,300,400,500,800 s/mm². PET events were simultaneously accumulated for 15 minutes and images reconstructed on the scanner platform. Images were sent to a dedicated workstation and processed with fusion software (MIM). A single radiologist measured tumor size on T1-weighted (T1), DWI at b=0 (b0), and PET images, drew a custom region of interest (ROI) around each tumor on the PET image, transferred the ROI to the ADC map, and measured maximum standard uptake value (SUV max) and minimum apparent diffusion coefficient (ADC min). Pathology reports were culled for ER, PR, Ki67 and

Her2Neu status. Same day PET/CT determined the presence of metastatic disease.

Results: Two tumors could not be identified on b0 images alone. Tumor size correlations per modality are depicted in Fig 1. Correlations between SUV max and ADC min were strong and are depicted in Fig 2. Tumors with increased T2 signal related to extensive necrosis and biopsy site

changes were grouped separately. Tumor marker data was not available for one patient; 3 lacked Ki67 data. Tumor markers Ki67 and Her2Neu and metastatic disease burden as a function of SUV max and ADC min are detailed in Fig 3a-c. As ADC min decreased, tumors were more likely to be Ki67+, Her2Neu- and have metastatic spread. No Ki67- tumors were seen below ADC min = 0.85 $\mu\text{m}^2/\text{ms}$ (fig 3a), and no Her2Neu- tumors or tumors associated with systemic metastases were seen above ADC min = 0.85 $\mu\text{m}^2/\text{ms}$. Only 2 patients were ER-; no trend was observed for ER or PR status.

Discussion: In this preliminary study, PET, CE T1 and DWI size correlation suggests increased glucose uptake, increased blood flow and increased cellularity are co-localized phenomena at the whole lesion level, and the inverse correlation between SUV max and ADC min is reinforced. Furthermore, ADC min thresholds may, with further study, serve as correlative biomarkers for Ki67 and Her2Neu. Finally, association between ADC min and systemic metastatic disease warrants further study as patients with lesions below a certain ADC min may benefit from whole body screening while others may not.

Conclusion: ADC min is inversely related to SUV max and may serve as a correlative biomarker for Her2Neu, proliferative index (ki67), and presence of metastatic disease.

