Diagnostic accuracy of NaF PET-MRI in differentiating bone metastases from benign bone lesions in metastatic prostate cancer.

Taylor Stone[1] and Luis Beltran[2]
[1]New York University, New York, NY, United States, [2]New York University, NY, United States

Target Audience: Radiologists and nuclear medicine physicians who interpret NaF PET-MRI.

Purpose: To evaluate the diagnostic accuracy of NaF PET-MRI in differentiating bone metastases from benign bone lesions, such as degenerative changes, in patients with metastatic prostate cancer. Accurately determining the number of lesions has become crucial for treatment planning as distinction is made between low- and high-burden disease.[1]

Materials and Methods: 11 patients with prostate cancer and bone metastases underwent NaF PET-MRI. The MRI included anatomic T1/T2/STIR sequences as well as diffusion-weighted imaging (DWI) using b values of 50 and 800. Each bone lesion was tabulated as benign or metastatic for each image type using either NaF PET-MRI, NaF PET-CT, or biopsy as the gold standard. Bone scintigraphy was available in 7 of the 11 patients and read independently without knowledge of the PET-MR results. SUVmax on PET and ADCmin, mean, max on DWI was measured for each lesion. Mixed model analysis of variance (ANOVA) was used to compare benign and malignant lesions in terms of each measure. Specificity, sensitivity, and overall accuracy for discrimination of benign and malignant lesions using each modality (BS, PET, DWI, PET/MRI) were calculated. Area under the ROC curve (AUC) achieved by each measure, threshold to define lesions as test positive for malignancy that maximized the average sensitivity and specificity, and sensitivity and specificity achieved at the indicated threshold were calculated.

Results: 36 total bone lesions were evaluated, including 21 metastases and 15 benign lesions. ADCmean was significantly lower ($p=0.008$) and SUVmax significantly higher ($p=0.024$) among malignant lesions than benign lesions. No significant difference between malignant and benign lesions was seen with ADCmin ($p=0.09$) and ADCmax ($p=0.140$). Specificity, sensitivity, and overall accuracy of each modality was: 100%, 31%, 65% for BS; 53%, 86%, 72% for DWI; 13%, 100%, 64% for PET; 100%, 86%, 92% for PET/MRI. AUC, threshold, and achieved sensitivity and specificity at that threshold for each parameter was: 0.7, >17.95, 62%, 80% for SUVmax; 0.67, ≤1.377, 56%, 87% for ADCmax; 0.8, ≤0.6224, 67%, 93% for ADCmean; 0.6, ≤0.221, 82%, 47% for ADCmin. AUC of ADCmin was significantly lower than that of ADCmean ($p=0.012$). There were no other significant differences between measures in terms of AUC ($p>0.1$).

Discussion: The results of this study have affected the way in which NaF PET-MRI is read at our institution. NaF PET is very sensitive for detecting osseous metastases and is the first sequence we evaluate. For every focus of uptake that is greater than background marrow, we then turn to the anatomic MRI sequences, to determine if the focus corresponds to a metastasis or a benign lesion. If there is any doubt on the anatomic MRI sequences, we then use the DWI/ADC map to help reach a conclusion on the lesion. Overall, the results are very accurate as demonstrated. The only location in which we are observing false negative PET-MRI lesions, are in the ribs, which were verified as true positives on NaF PET-CT. This is secondary to the lack of spatial resolution of the ribs on our routine protocol.

Conclusion: NaF PET-MRI as a hybrid imaging study shows higher specificity, sensitivity, and overall accuracy than bone scintigraphy, PET or DWI in isolation in differentiating between metastatic and benign bone lesions. Accurately defining the number of lesions has important treatment implications as prostate cancer treatment is generally based on disease burden.

References:

1. Sweeney C, Chen Y-H, Carducci MA, et al: Impact on overall survival with chemohormonal therapy versus hormonal therapy for hormone-sensitive newly metastatic prostate cancer: An ECOG-led phase III randomized trial. ASCO Annual Meeting. Abstract LBA2. Presented June 1, 2014.