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Su, MYL

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Comparison of whole-body PET/CT and PET/MRI in breast cancer patients: Lesion detection and quantitation of ¹⁸F-deoxyglucose uptake in lesions and in normal organ tissues

With the maturity of the MR-compatible PET imaging technology and rapidly increased installation of whole-body PET/MRI scanners, there is a strong interest to investigate the clinical role of PET/MRI, particularly in the management of oncologic patients. Several studies have been published to evaluate the location and contrast of detected lesions seen on PET/CT vs. PET/MRI, as well as to compare specific uptake value (SUV) in lesions and normal organs measured on PET/CT using CT-based attenuation correction vs. PET/MRI using MR-based attenuation correction.(1-8) Since PET/CT is an established clinical imaging modality for characterizing and staging of diseases, most PET/MRI imaging studies were designed as an add-on after the patient completed the PET/CT imaging, therefore capturing the uptake at a different time after a single-injection of the PET tracer, most commonly [F-18]FDG. Other than the biological factors that will lead to different tracer uptake and clearance after different waiting times, the difference in the design of PET scanners and the attenuation correction methods based on CT and MR all contributed to the differences in measured SUV by PET/CT and PET/MRI.

In this article Pace and colleagues studied a series of 36 consecutive breast cancer patients, with a total of 74 FDG-positive lesions, including 25 primary tumors, 35 metastatic lymph nodes, and

14 distant metastases. The anatomic allocation of PET findings using CT and MRI was compared. The contrast of detected lesions was visually scored, and the quantitative SUV_{max}, SUV_{mean}, and metabolic tumor volume (MTV) were measured on PET/CT and PET/MRI for comparison. Overall, there was an excellent correlation in the location, contrast, and SUV of detected lesions on PET/CT vs. on PET/MRI. The results of primary tumors, metastatic lymph nodes and distant metastases were also separately analyzed and yielded similar conclusions. It was found that the SUV of lesions measured on PET/MRI was consistently higher than on PET/CT. In one earlier study published by this group, they measured SUV from breast lesions at two different times after injection of [F-18]FDG using PET/CT, and found that malignant lesions showed an increase in FDG uptake with a longer waiting time.(9) In the present study by Pace et al., PET/CT was acquired at 60±10 min after injection; and PET/MRI was acquired at 88±29 min after PET/CT imaging, thus the longer waiting time might partially explain the higher SUV in the analyzed breast cancers measured by PET/MRI. Other differences in design of PET scanner and CT- vs. MR-based attenuation correction methods may also lead to differences in measured SUV's.

Quantitative measurement of SUV is known to have a high variation,(10) and it is not critical in clinical management and care of cancer patients. Other PET/CT vs. PET/MRI comparison studies published so far all reported that the obtained information for assessment of disease is highly consistent.(1-6) In one large series study of 134 patients with cancer with a non-central nervous system primary neoplasm, it was concluded that PET/MRI can provide additional information that affects the care of patient which is unavailable from PET/CT.(6) That said, quantitative measurement of SUV may be important in the setting of conducting multi-center

clinical trials, as shown in the effort of the PET Core Laboratory of the American College of Radiology Imaging Network (ACRIN) to certify trial participation sites by standardizing SUV calibration using uniform cylinder phantoms.(11) Due to the technical complications, it will be much more difficult to standardize the SUV measured by PET/CT and PET/MRI. For quantitative analysis of SUV, more research is needed to further understand the attenuation correction effects based on CT and MR and standardize them based on careful calibrations.

For care of breast cancer patients, PET/CT is mainly used to evaluate metastatic diseases. With a higher SUV offered by PET/MRI and the additional information that may be provided by MRI, e.g. diffusion weighted imaging and perfusion-weighted imaging, it is foreseeable that combined PET and MR imaging using a fully-integrated whole-body PET/MRI scanner will play an important clinical role. For example, whole-body diffusion weighted imaging is a promising method for detecting metastatic lymph nodes, and there are studies to compare the apparent diffusion coefficient measured by diffusion weighted MR imaging that is related to the cellular density with the metabolic activities measured by PET.(12) Combining the obtained information from both modalities will very likely improve the accuracy in diagnosis of metastatic lymph nodes. With the steady increase of whole-body PET/MRI scanners, more research results are expected to become available to demonstrate the added value of combined MRI, which may provide evidence for justifying the choice of PET/MRI over the current standard of PET/CT in management of breast cancer patients.

M.-Y. L. Su, PhD

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