PET/MRI - Is it time for its rule?

In current era of hybrid medical imaging, PET/CT has been the front liner since its introduction in 1999. In oncology, 18-Flouro-deoxyglucose (FDG) based PET/CT has become a standard of care of in management of various tumors. It is important to be cognizant of PET/CT s limitation like misregistration (due to non-simultaneous acquisition), lower soft tissue characterization (CT limitation) and non-specificity of FDG (uptake in glucose dependent malignant and benign conditions). Non-specificity of FDG has been addressed by introduction of many tissue specific tracers like prostate specific membrane antigen (PSMA) and fibroblast activating protein inhibitor (FAPI). Misregistration due to involuntary respiratory movements can be minimized by gating but those caused by other factors like involuntary visceral or patient movement are difficult to rectify with optimal adequacy. CT limitation of tissue contrast has been addressed by replacing CT component with MRI on PET/CT gantry which is a remarkable break through. After continuous and robust technological advancement, PET/MRI models with simultaneous acquisition capability have been developed. In 2011, first PET/MRI was approved by Federal Drug Administration (FDA) of USA for clinical imaging due to its high tissue contrast and excellent coregistration of PET and MRI images due to simultaneous acquisition.[1]

Most of the existing PET/MRI are equipped with 3-T (Tesla) magnet coupled with lutetium based avalanche photodiodes (APD) having high energy and time resolution. In PET/CT imaging, CT images are used for PET attenuation correction but in PET/MRI systems produce MR attenuation-correction (MRAC) images which use Dixon MRI sequences to assign each voxel as fat, air, soft tissue, or bone.[2]

Because of excellent soft tissue contrast, PET/MRI is considered to have better clinical utility in abdominopelvic oncological imaging (better performance in T and N staging).[3] PET/MRI offers unique advantages for patients with prostate cancer, and in future it may become the imaging modality of choice for initial staging of patients at high risk for prostate cancer.[4] Regardless of the radiotracer selected (FDG, PSMA, Fluciclovine which may show uptake in BPH as well), PET/MRI is particularly advantageous in better detection of small-volume disease in the abdomen and pelvis. Post-treatment fibrosis has been a challenge with stand-alone MRI but FDG PET/MRI helps the readers due to improved lesion characterization and higher detection efficiency of post-treatment residual pelvic lymph node metastases. In rectal cancer, stand-alone MRI has better ability of T and N staging. However, some subcentimeter nodes despite of having metastasis might be missed. But FDG based PET/MRI improves reader s confidence and detection of pelvic nodal metastatic disease by using the complementary metabolic and morphological signals.[5,6] Similarly in pancreatic cancers, accurate staging (using CT and MRI or FDG PET/CT in equivocal cases) is important to ascertain respectability or metastatic disease. A prospective study has shown that FDG PET/MRI has led to changed management in about 50% cases with pancreatic adenocarcinoma.[7] Patients with pancreatic adenocarcinoma on neoadjuvant or adjuvant chemotherapy, FDG PET/CT has shown early response assessment and allows early treatment change in non-responders.[8] In hepatobiliary malignancies, dynamic CT and MRI are the standard-of-care and addition of FDG PET/MRI would improve differentiation of physiologic and malignancy-related radiotracer activity. In patients with cholangio-carcinoma, a recent study with FDG PET/ MRI has shown change in treatment plans in about 30% patients.[9] In gynecological malignancies, CT and MRI are cornerstones for of staging workup. It has been observed that FDG PET/MRI offers a potential benefit in these patients owing to superior soft-tissue contrast.[10] FDG PET/MRI can accurately differentiate pelvic lymph node metastases from physiologic activity in an ovary. FDG PET/MRI can also assess the burden of peritoneal carcinomatosis which is an important information for surgeon prior to enter for de-bulking.[11] In 2018, revised guideline of International Federation of Gynecology and Obstetrics (FIGO) for cervical cancer staging has

Submitted 11 June 2022, Accepted 11 June 2022

stressed upon cross sectional imaging for accurate staging and prognostication.[12,13] Recent studies have shown that in cervical cancer staging FDG PET/MRI has outperformed stand-alone CT and MRI and changed in management in about 40% cases.[14]

However, it is important for the reporting physicians to be cognizant of limitations of PET/MRI as these could have a significant impact upon accuracy of reporting. For sclerotic bony metastasis, there is possibility of underestimation of standardize uptake value (SUV) as MRAC images don t account for effects of cortical bone.[15] This limitation is comparable with PET/CT which also has lower sensitivity for sclerotic metastases. PET/MRI has limited detection efficiency for pulmonary nodules less than 10 mm.[16] Metallic implants in body can lead to loss of signals on PET images due to dephasing of MR and MRAC images and in such cases review of non-attenuation corrected PET (NAC-PET) images is advised. Similarly, PET/CT with metallic implants gives artefacts on CT and falsely high SUVmax (over-estimation) and review of NAC-PET is also advised.

PET/MRI being an FDA approved hybrid imaging modality has significantly higher soft tissue characterization and simultaneous image acquisition gives near-perfect image coregistration as well. Since MRI is considered as standard of care in workup of abdominopelvic oncologic malignancies, addition of PET based metabolic information will definitely enhance the accuracy in staging, restaging and response assessment. Since PET/MRI enables more appropriate management than PET/CT in abdominopelvic malignancies, a histology-based triage of patients to either PET/MRI or PET/CT may be meaningful.

Conflict of Interest: None

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