Whole-body MRI and Whole-Body Dual-Modality PET/CT for tumor staging in Oncology

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Introduction: In patients with malignant diseases accurate tumor staging is of vast importance as different therapeutic options strongly depend on the tumor stage. Local assessment of tumor size, potential infiltration of adjacent organs, and involvement of regional lymph nodes may be covered by only a limited field-of-view. Determination of distant metastases, however, mandates a whole-body examination. Contrast-enhanced whole-body MRI may be used for whole-body tumor staging, but differentiation of benign from malignant lesions can be problematic due to the lack of functional information. Recently available dual-modality Positron Emission Tomography / Computed Tomography (PET/CT) systems provide accurately fused functional and morphologic data sets and have proven to be of benefit over the two imaging modalities alone. PET/CT, however, mandates the administration of iodine-based contrast agents with an increased allergic potential over gadolinium. Furthermore, PET/CT imaging goes along with a significant radiation exposure. The purpose of this study was, therefore, to compare the values of whole-body MRI and whole-body PET/CT imaging for staging of different malignant diseases.

Methods: 98 patients with various primary malignancies underwent tumor staging with whole-body PET/CT and whole-body MRI covering the head to the upper thighs. MRI was performed on a 1.5 T scanner (Sonata™, Siemens Medical Solutions) using a commercially available rolling table platform (Body*Surf*™) with an integrated torso phased array coil for whole-body coverage. The imaging protocol included T1 and T2-Haste of the liver and the thorax, complemented by seven overlapping contrast-enhanced axial 3D-VIBE data sets for whole-body coverage. PET/CT imaging (biograph™, Siemens Medical Solutions) was accomplished one hour after intravenously injecting 350 MBq of [^{18}F]-2-fluoro-2-deoxy-D-glucose (FDG). 140 ml of a iodinated contrast agent (300mg iodine/ml) were applied to provide fully diagnostic CT data. PET/CT and MRI data sets were evaluated each by two radiologist in consensus and PET/CT images were additionally viewed by two nuclear medicine physicians. Readers were blinded to the results of the other imaging procedure and diagnostic accuracies of the two imaging procedures were compared for assessing the TNM stage. Histology and a clinical follow-up of after a mean 273 days served as the standards of reference. Differences between the two staging procedures were tested for statistical significance by the McNemar's test.

Results: The overall TNM tumor stage was correctly determined in 53 / 98 patients (54%) with MRI and in 75 / 98 patients (77%) with PET/CT ($p<0.0001$). PET/CT had a direct impact on patient management in 12 patients compared to MRI, while in 2 patients MRI changed the therapy regiment compared to PET/CT. Separate assessment of T-stage revealed MRI to be accurate in 24 / 46 of patients (52%), with pathological T-stage verification and PET/CT in 37 / 46 (80%) of these patients ($p=0.0002$). N-stage was correctly determined in 77 / 98 patients (79%) with MRI and in 91 / 98 of the patients (93%) with PET/CT ($p=0.0013$). MRI, however, was superior to combined PET/CT imaging when determining the presence of bone metastases: 80 bone metastases were detected with MRI in 11 patients (true positives), while PET/CT revealed 75 lesions in 8 patients (see Fig. 2). Abdominal parenchymal organs were assessed equally well with both imaging techniques.

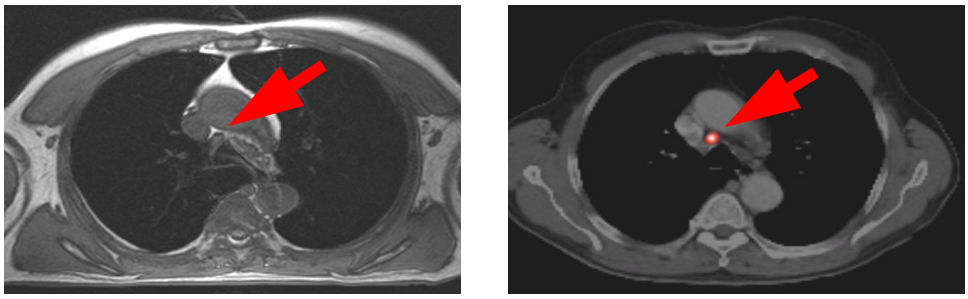

Fig.1: 66 yo male with bronchial carcinoma of the right lower pulmonary lobe. MR imaging (left image) demonstrates mediastinal lymph node which was not pathologically enlarged. The PET/CT data sets, however, revealed focally increased glucose metabolism within the mediastinal lymph node suspected of mediastinal metastasis. Histology later proved mediastinal lymph node involvement (N2-disease).

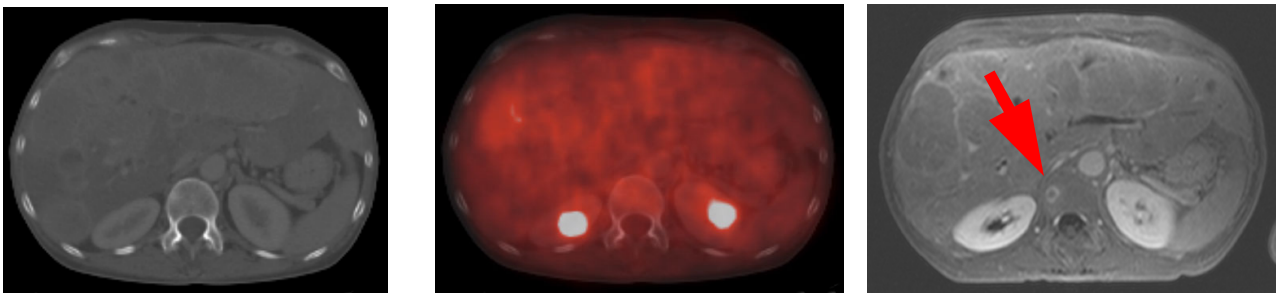

Fig.2: 49 yo female with neuroendocrine tumor of the pancreas. CT (left image) and fused PET/CT (middle image) data do not demonstrate any pathology. MRI (right image), however, reveals osseous lesion with peripheral contrast enhancement. Biopsy proved this lesion to be a bone metastasis.

Discussion: PET/CT proved superior in detecting lymph node metastases and pulmonary metastases, while MRI was able to more accurately assess skeletal metastases. The study indicates that whole-body PET/CT and whole-body MRI examinations complement one another in the staging of malignant diseases.