Whole Body Imaging Multiparametric (T2/DWI/DCE) and Advanced Multimodality (PET/CT) for Detection of Recurrent Metastatic Cancer

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INTRODUCTION: The ability to diagnose recurrent metastatic disease would be an advancement in patients. The purpose of this study was to investigate the potential use of high field MR (3T) using whole body diffusion weighted (WB-DWI), T2-weighted (T2WI) and dynamic contrast enhancement imaging (DCE) coupled with advanced positron emission tomography radiotracers and CT (PET/CT) for the detection of the presence or recurrence of metastatic disease in patients.

METHODS: Fifteen subjects were scanned. Five patients (age:61±6) with known malignancy (prostate) with rising PSA (biochemical relapse) were prospectively scanned with WB-MR methods using a 3T MRI scanner (MAGNETOM Trio a Tim System, Siemens Healthcare). In addition, 10 normal subjects (age:46±12) were included to determine the normal range of expected ADC values. Coronal or sagittal fat-suppressed T_2-weighted(TR/TE=6640/84ms,FOV=40x40cm^2,256x256, slice thickness (ST)=4mm). T1-STIR(TR/TE=4340/53msFOV=40x40cm^2, 448x444, IR=220ms) and DWI images (TR/TE=4000/67ms, b=50,400-800 sec/mm^2, 192x192, FOV=40x40cm^2, ST=4mm) using GRAPPA (acceleration factor=2, 24 phase encode lines, 69 EPS) were acquired [1]. 2D PACE (Prospective Acquisition Correction) technique was used in areas of the body with increased motion (thorax, abdomen) to decrease artifacts. Dynamic contrast-enhanced images T_1WI(TR/TE=20/4, 128×128 matrix, 4mm slice thickness) were obtained after intravenous administration of 0.1 mmol/kg gadodiamide contrast agent. Total acquisition time (coronal or sagittal) was approximately 40-50 mins. PET/CT data (Discovery LS, GE Healthcare) was acquired on patients after fasting for 4 hours. F18-fluorodeoxyglucose (^{18}FDG) or another advanced radiotracer, ^{11}C-acetate, ^{11}C-choline and/or Na^{18}F was injected. The FDG dose was calculated based on the weight (kg) of the patient. After the uptake phase, which lasts 45-60 minutes, the patient was positioned and images were acquired. If present, metastatic disease was confirmed by clinical standards. Whole body trace ADC maps and T_2WI were constructed for quantitative analysis and ROIs were drawn in regions of normal and abnormal appearing signal intensity in the DWI images and localized to the ADC map (see figures). DCE metrics were measured using permeability and extravascular/extracellular volume fraction. PET/CT data was compared for localization and Standardized Uptake Values (SUV) were calculated. Descriptive and ANOVA statistics are presented as mean±standard deviations.

Fig. 1. 64 y/o patient with increasing PSA, multimodality whole body imaging for interrogation of metastatic disease. Potential recurrence was found in prostate.

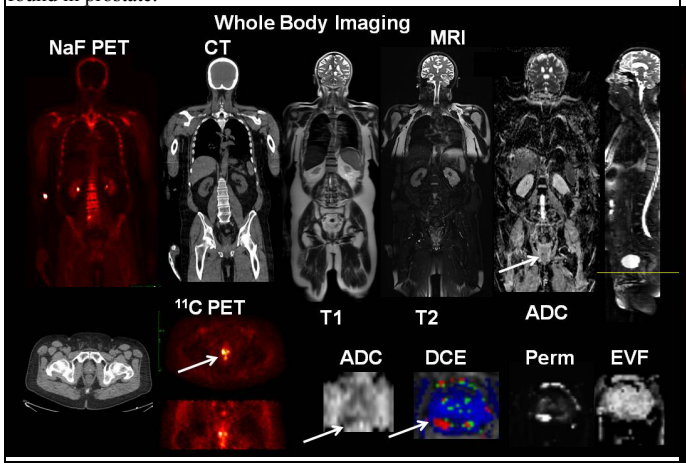
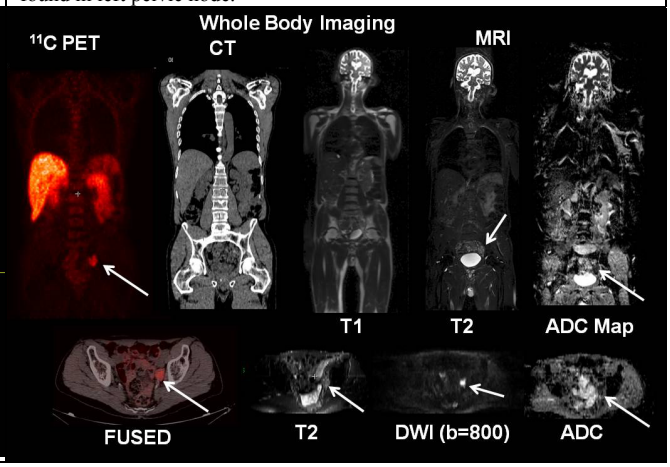


Fig. 2. 71 y/o patient with increasing PSA, multimodality whole body imaging for interrogation of metastatic disease. Potential recurrence was found in left pelvic node.



RESULTS: Whole body imaging using both multiparametric MR and advanced PET/CT is feasible. WB-DWI/DCE was able to distinguish potential metastatic regions in 3 patients, but none were found in the other two. Figure 1 demonstrates the multimodality WB methods, with a region of decreased ADC (0.92±0.05x10^{-3}mm^2/s in the right peripheral zone) compared to normal peripheral zone (1.49±0.05x10^{-3}mm^2/s). There were positive findings on DCE-MR and ^{11}C-choline PET, but none seen in the Na^{18}F. Regions of decreased ADC map values were found in the left lateral pelvic nodes (1.1±0.15x10^{-3}mm^2/s compared to 1.47±0.15x10^{-3}mm^2/s;R side). Finally, in metastatic adenopathy, there were decreased ADC values (0.83±0.08 x10^{-3}mm^2/sec) and increased SUV (5.6) as shown in Figure 2. ADC values in normal subjects for the peripheral zone of the prostate were 1.71±0.21 x10^{-3}mm^2/sec (left), 1.69±0.20 x10^{-3}mm^2/sec (right). These ADC values were significantly different (p=0.01) between patients and normal subjects.

DISCUSSION: We have demonstrated the feasibility of combining WB-DWI/ADC and DCE-MR at 3T with advanced PET/CT radiotracers to identify and potentially characterize metastatic disease[2-6]. There were significant differences in the ADC values in areas of metastatic disease compared to corresponding anatomical structures in normal subjects. Our data suggest the potential of multimodality WB methods for characterization of metastatic disease.

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