Correlation of glucose metabolism and apparent diffusion coefficient of malignant disease evaluated with simultaneous hybrid PET/MRI

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Target audience: Clinicians and researchers who work in cancer imaging.

Purpose: Positron emission tomography (PET) with [^{18}F]flurodeoxyglucose (FDG) provides quantitative information regarding cellular glucose metabolism. The standardized uptake value (SUV) is commonly used to evaluate tumor glucose metabolism, which is biomarker for clinical diagnosis of tumor malignancy, disease recurrence, and metabolic response to therapy[1]. Diffusion-weighted MRI (DWI) is also increasingly used in the evaluation of malignant disease. By combining two or more images of the same area with different diffusion weighting, water movement can be quantified as the apparent diffusion coefficient (ADC)[2] . Like the SUV from PET/CT, ADC has been used clinically to differentiate benign from malignant tumors and to assess tumor grade, delineate tumor extent and predict survival[3]. Results of several studies have suggested an inverse correlation between SUV and ADC across varying malignancies including the first study evaluated on a simultaneous PET/MRI hybrid imaging system[4], which has the capability of eliminating registration error due to separate PET/CT and MRI examinations and minimizing potential physiological and treatment changes due to the time interval between the PET and MRI examinations. The purpose of this study is to continue to investigate whether FDG-PET and ADC have significant correlation evaluated on simultaneous PET/MRI.

Methods: Seven patients provided written informed consent for the PET/MRI examination and were scanned on the PET/MRI system (Biograph mMR, Siemens Healthcare) with standard clinical protocol. The PET acquisition time was 4 minutes per bed and PET images were reconstructed with 3D ordinary Poisson ordered subsets expectation-maximization algorithm at 3 iterations and 21 subsets. DWI was performed with a single-shot spin-echo echo-planar imaging sequence at two b values, 0 and 800 s/mm^2. Region of interest (ROI) delineation was performed with region-growing for PET and with manual drawing for ADC map. Mean ADC (ADCmean), minimum ADC (ADCmin), mean SUV(SUVmean) and maximum SUV (SUVmax) were calculated for each ROI. Relations between SUVmax and ADCmin and between SUVmean and ADCmean were assessed with the Spearman correlation coefficient.

Results: Ten neoplastic lesions with a long axis diameter of greater than 1.5 cm were selected for analysis. The mean SUVmean, mean SUVmax, mean ADCmean and mean ADCmin were 6.9±2.6, 11.4±5, 1.15±0.5 x 10^{-3} mm^2/s and 0.37±0.28 x 10^{-3} mm^2/s, respectively. There were no significant correlation either between SUVmean and ADCmean or between SUVmax and ADCmin (Fig.1). Fig.2 shows ADC and SUV map of a peripancreatic lymphadenopathy from a 56-year-old woman diagnosed with cervic carcinoma. A voxelwise weak correlation between the ADC values and SUV was found (Pho = 0.078 with P<0.05). Pattern with high SUV but low ADC and low ADC but high SUV cannot be founded with cluster analysis (Fig.2(a)).

Discussion: FDG-PET allows discrimination of tissues by glucose metabolism based on intracellular entrapment of phosphorylated FDG, with a greater FDG uptake, as measured by SUV, observed for tissues with increased metabolic activity (eg, malignant lesions). DWI/ADC allows tissue characterization based on sensitivity to the molecular motion of water. The degree of diffusion restriction observed correlates with cellular density for multiple human malignances. For example, results of previous studies have suggested a mixing result on inverse correlation between SUV and ADC across varying malignancies acquired on separate PET/CT and MRI. No significant correlation was found in head and neck squamous cell carcinoma[5] but correlation exists in cervical cancer[6]. In this study, we evaluated ADC value and SUV produced from simultaneous acquisition of MRI and PET data in the patients with malignant disease irrespective of tumor type. Unlike the previous study[4], no significant correlation was found either between SUVmean and ADCmean or between SUVmax and ADCmin. This may be due to the limitation of small population in this study. However, the mixed and negative correlations between ADC and SUV observed in this and previous studies suggest that these two parameters may yield related but possibly complementary information. This is also supported by the cluster analysis on peripancreatic lymphadenopathy.

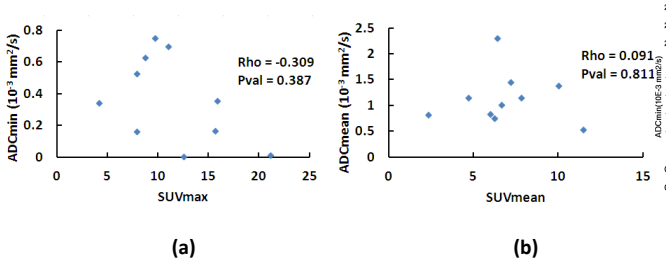

Fig. 1 Relationship between ADC and SUV, Rho and Pval are Spearman correlation coefficient and P value, respectively. (a): ADCmin versus SUVmax (b): ADCmean versus SUVmean.

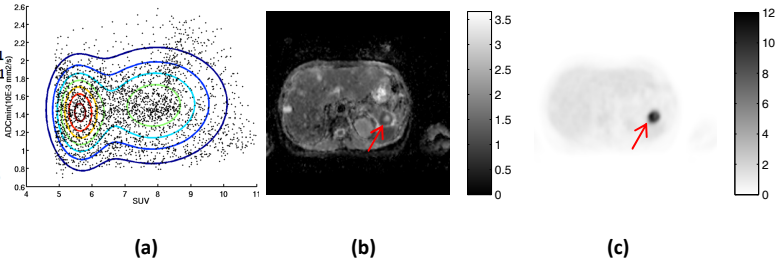

Fig.2 Voxelwise scatterplot of ADC and SUV (a) of a peripancreatic lymphadenopathy dictated by red arrow in ADC map (b) and SUV map (c) A cluster analysis (Gaussian distribution) was also shown in (a)

Conclusion: In this abstract, correlation analysis of simultaneously acquired DWI/ADC and FDG PET of malignant disease in a simultaneous PET/MRI system was present. Preliminary result does not show a significant correlation between ADC and SUV. Further studies of larger and better defined patient populations combined with improvements in quantitative accuracy are needed in the future.

References:

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