Quantitative analysis of indexes from DWI and PET/CT in primary rectal cancer

J. Gu[1], P-L. Khong[1], S. Wang[1], Q. Chan[2], W. LAW[3], R. Liu[3], and J. Zhang[1]
[1]Diagnostic Radiology, The University of Hong Kong, Hong Kong, Hong Kong, Hong Kong, [2]Philips Healthcare, Philips Electronics Hong Kong Limited, Hong Kong, Hong Kong, Hong Kong, [3]Division of Colorectal Surgery, The University of Hong Kong, Hong Kong, Hong Kong, Hong Kong

Introduction: The apparent diffusion coefficient (ADC), a quantitative parameter measured on diffusion-weighted imaging (DWI), has been shown to be useful for evaluating solid tumors. On the other hand, 18F-fluorodeoxyglucose (18F-FDG) uptake on positron emission tomography (PET), quantified by the standardized uptake value (SUV), is a useful marker for the level of tumor metabolic activity. However, the experience of applying DWI or PET /computed tomography (PET/CT) in evaluation of rectal cancer is relatively limited. We aim to assess the correlations between parameters measured on DWI and 18F-FDG PET in rectal caner.

Materials and Methods: 33 consecutive patients with newly diagnosed and pathologically confirmed rectal adenocarcinoma and having undergone both MRI and PET/CT examinations were included in this study. Routine T1, T2, DWI and contrast-enhanced sequences were performed on a 3T scanner. Flex-L coil with using SENSE technique was placed over the pelvis to reduce gas effect to imaging quality. Transverse free-breathing DWI was obtained by using a single-shot multi-slice echo planar imaging (EPI) sequence with short TI inversion recovery (STIR) fat-suppression and slice-selection gradient reversal technique with the following parameters: TR/TE = 7036/48 ms, FOV = 40×33 cm, matrix size = 188 ×159, slice thickness = 5 mm, gap = 0, number of acquisitions = 4, sense factor = 2, b value = 0 and 1000 s/mm2. The acquisition time for DWI was approximately 4 minutes. ADC maps were generated to calculate ADCmean (average ADC for all voxels in tumor), ADCmin (lowest ADC among all voxels in tumor), tumor volume, and total diffusivity index (TDI = tumor volume / ADCmean) (Figure 1). PET/CT exams were performed within 1 week of MRI. A whole body PET scan with a 70-cm axial FOV, a 218×218 matrix and 3.27 mm thickness was obtained with five bed positions within 20 minutes. CT images were performed using the following scan parameters: FOV = 50cm, matrix = 512×512, collimation = 0.625 mm×64, pitch = 0.984, gantry rotation speed = 0.5 second, tube voltage = 120 kVp, and tube current = 200-400 mA. The CT images were then reconstructed at 2.5mm intervals to fuse with the PET images (Advanced Workstation 4.3; GE Healthcare). SUVmax, SUVmean, tumor volume and total lesion glycolysis (TLG) were calculated using a 50% threshold (Figure 2). Pearsons correlation test was used to detect the relationships between imaging parameters. Concordance analysis was performed to assess agreement between volumes measured on DWI and PET. One way ANOVA test was used to analyze differences of SUV and ADC values in terms of well, moderate or poorly differentiated rectal cancer.

Results: Significant negative correlations were found between ADCmin and SUVmax (r=-0.450, p=0.003), and between ADCmean and SUVmean (r=-0.402, p=0.020) (Figure 3). Significant positive correlations were found between TDI and TLG (r=0.634, p<0.001). Good agreement between tumor volumes measured on DWI and PET/CT was found, although PET tended to underestimate tumor volumes. There were no statistically significant differences in ADC or SUV values of well, moderate, and poorly differentiated adenocarcinoma groups, although there was a trend of having higher SUV and lower ADCmin values in the poorly differentiated tumors.

Conclusion: Significant correlations were found between ADC and SUV, and TDI and TLG values in primary rectal adenocarcinomas. ADC may thus have the potential as a useful biomarker in oncologic imaging.

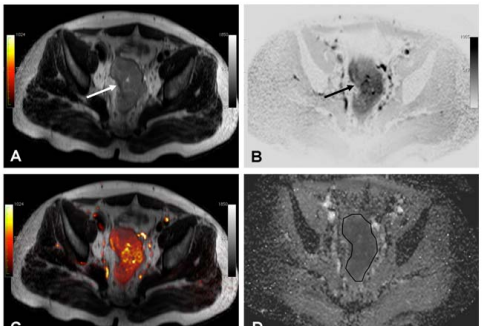


Figure 1: 55 year old man with moderately differentiated rectal adenocarcinoma. **A.** Axial single-shot TSE T2-weighted image of the pelvis shows a large rectal mass (arrow). **B.** Axial DWI image of the pelvis at the same slice location as **A.** is shown with inverted gray scale to demonstrate a PET-like image of the rectal mass (arrow). **C.** Fused image from **A.** and **B.** can be performed for easy viewing if desired. **D.** On the ADC map generated from **B.**, an ROI was manually drawn along the contour of the tumor (black line). Subsequenetly ADCmean, ADCmin, and the cross-sectional area of the tumor on this image were calculated by ImageJ software.

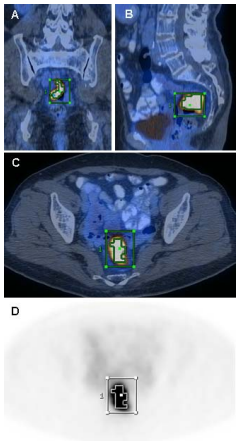
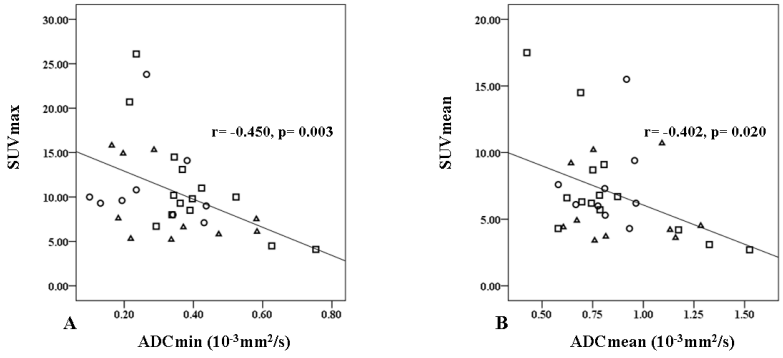


Figure 2: 82 year old woman with moderately differentiated rectal adenocarcinoma. **A-C.** Fused PET/CT images in coronal and sagittal reformatted planes, as well as in the axial plane show a hypermetabolic lesion in the rectum. A 3D ROI (green box) was placed to cover the entire lesion on the Advanced AW Workstation. **D.** From the corresponding PET images, SUVmax was measured. Subsequently SUVmean, tumor volume and TLG were calculated automatically using a threshold of 50% SUVmax.



Figures 3: Scatter plots showing the significant negative correlations between ADCmin and SUVmax (**A**), ADCmean and SUVmean (**B**). Δ=well differentiated tumor, □=moderately differentiated tumor, ○=poorly differentiated tumor.