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Dynamic Contrast-enhanced MRI of Primary Rectal Cancer at 3T: Correlation with Positron Emission Tomography

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Objective: Quantitative parameters on dynamic contrast-enhanced MRI (DCE-MRI) are useful biomarkers to reflect angiogenetic characteristics of tumor. 18F-fluorodeoxyglucose (18F-FDG) uptake on positron emission tomography (PET), quantified by the standardized uptake value (SUV), is a valuable marker for the level of tumor metabolic activity. We aim to assess the correlations between parameters measured on DCE-MRI and 18F-FDG PET in rectal cancer.

Materials and Methods: 27 consecutive patients (15 men, 12 women, 45-88 years) with pathologically confirmed rectal adenocarcinoma (6 well, 14 moderately, and 7 poorly differentiated adenocarcinomas) and having undergone both MRI and PET/CT were included in this study. MRI and PET/CT exams were performed within 1 week period. Routine T2-weighted, T1-weighted and contrast-enhanced sequences were obtained. SENSE-Torso coil with parallel imaging capability was placed over the pelvis. Patients were asked to fast for 4 hours before MR scanning. Pre-contrast 3D T1-wieghted fast-field echo (FFE) images of the tumor were obtained in the axial plane: TR/TE = 4.9/1.52 ms, FOV = 27× 40 cm, matrix size = 236× 344, slice thickness = 3mm, flip angle = 5, number of acquisition = 5, sense factor = 1.2. This was followed by DCE series using the same sequence except for flip angle = 15° , number of acquisition = 1, temporal resolution of 6.3 seconds for 10 slices, with total 35 dynamic scans. After one dynamic scan, Gd-DOTA was injected at 0.2ml/kg body weight intravenously followed by 25 mL saline at 3.5mL/s immediately using a power injector system (Spectris Solaris, MedRad, Indianola, PA, USA). 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). After image acquisition, functional maps of K^{trans}, k_{ep}, T1 and v_p were generated for DCE-MRI. Region of interests (ROIs) were manually drawn along the contours of each tumor on every slice to get average values of the above parameters for each tumor. Maximum of standard uptake value (SUVmax) and mean of standard uptake value (SUV mean) were calculated using a 50% threshold. Pearsons correlation test was used to detect the relationships between imaging parameters. One way ANOVA was used to analyze differences in imaging parameters among tumors of well, moderate or poor cellular differentiation.

Results: Significant correlations were demonstrated between k_{ep} and SUVmax (r=0.587, p=0.001), and k_{ep} and SUVmean (r=0.562, p=0.002). There were no correlations between K^{trans}, v_p, v_e values and SUVmax or SUVmean. No significant differences were found in imaging parameters between well, moderately and poorly differentiated adenocarcinoma groups, although there were weak differences in kep (p=0.071) and SUVmax (p=0.099). k_{ep}, K^{trans}, v_p, SUVmax, and SUVmean were found higher in poorly differentiated adenocarcinomas, however, it did not reach significant difference.

Conclusion: (1) Positive correlations were found between k_{ep} measured by DCE-MRI and SUV values measured by PET/CT in primary rectal adenocarcinomas. (2) Our findings may indicate that as rate constant between the extravascular-extracellular space and the blood plasma, k_{ep} during contrast washout phase is better associated with tumor metabolism than K^{trans} which is influenced by multiple factors during contrast uptake phase. (3) k_{ep} may have the potential as a useful biomarker to reflect biological characteristics of rectum cancer.

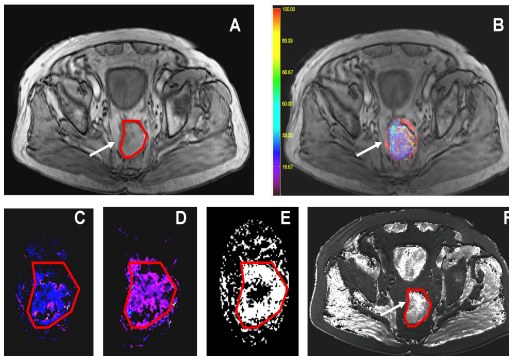


Fig. 1 88-year-old man with moderately differentiated rectal adenocarcinoma. **A.** On pre-contrast T1-weighted image, ROI was drawn (red line) along the contour of each slice of the tumor (arrow). **B.** Fused image of T1-weighted image and K^{trans} map generated by DCE-Tool software using a general kinetic model. **C-F.** ROIs (red line) were copied from **A** to tumor maps of k_{ep}, K^{trans}, v_p, and T1 image, respectively, which were generated by DCE-Tool software and with anatomic location identical to pre-contrast T1-weighted image.

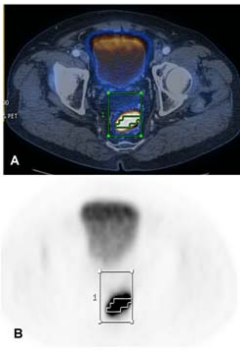
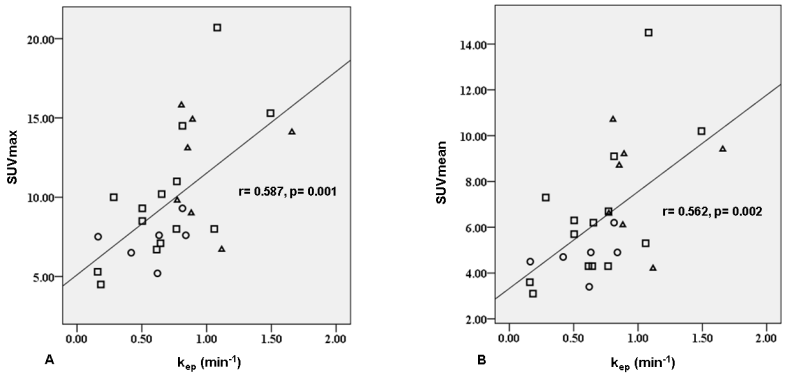


Fig. 2 82-year-old woman with moderately differentiated rectal adenocarcinoma. **A.** Fused PET/CT images in the axial plane show a hypermetabolic lesion in the rectum. A 3D ROI (green box) was placed to cover the entire lesion on the Advanced AW Workstation. **B.** From the corresponding PET images, 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 positive correlations between k_{ep} and SUVmax (**A**), k_{ep} and SUVmean (**B**). ○=well differentiated rectal cancer, □=moderately differentiated rectal cancer, Δ=poorly differentiated rectal cancer.