Molecular imaging of cervical cancer with multiparametric 18FDG/18FMISO PET-MRI at 3Tesla: a feasibility study
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Introduction
To demonstrate the feasibility of molecular imaging of cervix cancer with combined multiparametric positron emission tomography - magnetic resonance imaging (3T MP PET-MRI) with T2-weighted, dynamic contrast-enhanced MRI (DCE-MRI), diffusion-weighted imaging (DWI), the tracer 18fluoro-desoxy-glucose (18FDG) for the detection of increased glycolysis and the tracer18fluoromisonidazole (18FMISO) for detection of tumor hypoxia at 3T.

Material and Methods
5 patients with histopathological confirmed cervical cancer scheduled for radiation therapy were included in this IRB approved prospective study. All patients were examined with combined 3T MP PET-MRI. Examinations were performed no longer than 3 days apart. The MRI protocol consisted of an isotropic T2-weighted SPACE (TR/TE 89/4630; SI 3mm isotropic; matrix 384 x 384, TA 3min 40 sec), a DWI EPI sequence (TR/TE 82/x6300s; SI 5mm; b-values 50 and 850 sec/mm²; matrix 192 x 156; TA 2min 20 sec) and an axial T1 VIBE with fat-sat (TR/TE 1.4/3.4 SI 3mm; matrix 480 x 360; TA 4min) before and after application of a standard dose Gd-DOTA (Dotarem). Patients fasted at least 6 h before injection of approximately 300-700 MBq 18FDG based on the patients weight. No fasting was needed before injection of 330 MBq 18FMISO. Scanning was started 45 min after injection for 18FDG and 180min after injection of 18FMISO. Blood glucose levels were <150 mg/dl. All patients were subjected to 18FDG/18FMISO -PET-CT scanning using a combined PET-CT in-line system (Siemens Biograph, Siemens, Erlangen, Germany). CT data was used for attenuation correction. Co-registration of imaging data and image fusion were performed. 3T MP 18FDG/18FMISO PET-MRI was assessed for tumor size, enhancement-kinetics, restricted diffusivity and 18FDG/18FMISO -avidity.

Results
Molecular imaging of cervix cancer with MP PET-MRI using T2-weighted, DCE-MRI, DWI, 18FDG and 18FMISO at 3T was successfully performed in all patients. Tumor volumes ranged from 111.3-440cc (median: 213.2cc). All tumors demonstrated restricted diffusivity with ADC values ranging from 0.56-0.82 x 10^-2 mm^2/sec (median 0.72 x 10^-2 mm^2/sec). Four tumors demonstrated initial strong enhancement followed by a wash-out (type III) and one tumor demonstrated initial strong enhancement and followed by a plateau (type II). All tumors were highly 18FDG-avid with SUVmax values ranging from 11.9-25.6 (median 18.2). None of the tumors were highly 18FMISO-avid (SUVmax 1.3-2.4, median 1.87). However in two patients 18FMISO PET identified 18FMISO-avid spots (SUVmax 2 and 2.4) within the 18FDG-avid lesion indicative of areas of tumor hypoxia (Fig.1 and 2- same patient, hypoxic area indicated by arrow).

Conclusion
Molecular imaging of cervical cancer with MP PET-MRI using T2-weighted, DCE-MRI, DWI, 18FDG and 18FMISO at 3T is feasible. MP 18FDG/18FMISO PET-MRI at 3T provides unique information on tumor morphology and biology. MP 18FDG/18FMISO PET-MRI at 3T can identify areas of tumor hypoxia, which are more resistant to radiation therapy and necessitate dose-escalation and thus might improve therapy planning and assessment of treatment response.


Fig.1 Fig.2