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 ^{18}fluoro-desoxy-glucose (^{18}FDG) for the detection of increased glycolysis and the tracer^{18} fluoromisonidazole (^{18}FMISO) 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 40sec), 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 ^{18}FDG based on the patients weight. No fasting was needed before injection of 330 MBq ^{18}FMISO. Scanning was started 45 min after injection for ^{18}FDG and 180min after injection of ^{18}FMISO. Blood glucose levels were <150 mg/dl. All patients were subjected to ^{18}FDG/^{18}FMISO -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 ^{18}FDG/^{18}FMISO PET-MRI was assessed for tumor size, enhancement-kinetics, restricted diffusivity and ^{18}FDG/^{18}FMISO -avidity.

Results

Molecular imaging of cervix cancer with MP PET-MRI using T2-weighted, DCE-MRI, DWI, ^{18}FDG and ^{18}FMISO 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 ^{18}FDG-avid with SUVmax values ranging from 11.9-25.6 (median 18.2). None of the tumors were highly ^{18}FMISO-avid (SUVmax 1.3-2.4, median 1.87). However in two patients ^{18}FMISO PET identified ^{18}FMISO-avid spots (SUVmax 2 and 2.4) within the ^{18}FDG-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, ^{18}FDG and ^{18}FMISO at 3T is feasible. MP ^{18}FDG/^{18}FMISO PET-MRI at 3T provides unique information on tumor morphology and biology. MP ^{18}FDG/^{18}FMISO 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.

References: Antoch EJNMI 2009, Georg Radiother Oncol 2008, Grosu Int J Radiat Oncol Biol Phys 2007, Mayr Int J Radiat Oncol Biol Phys 2010

Fig.1 Fig.2