MR-PET based Diagnosis of Gliomas – A Prospective Comparison of 3D MRSI and ^{18}FET PET

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Target audience: Scientists working in the field of MR-PET and/or neuro-oncology, clinicians

Purpose: Diagnosis of brain tumours is widely based on MR imaging, however, limitations of diagnostic specificity remain. An additional method of value for this purpose is PET imaging of O-(2-[18F]Fluorethyl)-L-Tyrosine (FET) uptake[1]. While FET imaging has been shown to demonstrate high sensitivity for detection of gliomas [1], 30% of the low-grade gliomas show low or no uptake of ^{18}FET, which may result in false negative diagnoses. Similarly MRS has been shown to be of value for identifying low-grade gliomas [2]. In this study, the association of FET and MRS measures was investigated in high- and low-grade gliomas using a hybrid PET-MR scanner. This should help in the future to delineate and extrapolate patterns in the MRS data which identify low-grade gliomas where FET PET is not sensitive. A secondary goal was to examine the associations between distributions of increased FET uptake and metabolites detectable by short echo time MRSI, such as choline, N-acetyl-aspartate and myo-inositol.

Methods: All measurements were performed in accordance with local ethics committee guidelines and informed consent was obtained prior to measurement. 20 subjects, average age 44 ±15.5 years (10 female, 10 male), with suspected glioma were included into the study. After the administration of 3 Mbq/kg body weight of FET list mode data was acquired over 50 min. Simultaneously, a T_1-weighted MPRAGE data set, T_2 data and high-resolution whole-brain MR spectroscopic data was acquired by employing a volumetric echo planar SI (EPSI) sequence with TE=17.6 ms and 16 min total acquisition time [3]. The data were acquired on a Siemens (Erlangen, Germany) 3T TIM TRIO with simultaneous PET measurement using the Siemens BrainPET insert inside the 3T magnet. Maps of N-acetylaspartate, choline, myo-inositol, and lactate were calculated using the MIDAS software package [4].

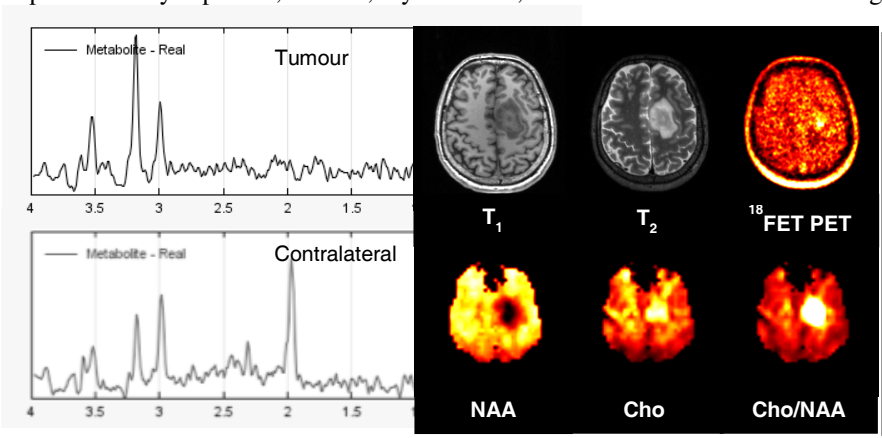

Figure 1: Example spectra, T_1/T_2 MRI, FET uptake, and metabolite maps in a subject with a high-grade astrocytoma. The spectrum of a voxel inside the tumour shows increased choline (Cho) at 3.2 ppm and no N-acetylaspartate (NAA) signal at 2 ppm. The contralateral side shows the normal spectrum. The respective metabolite maps show a larger tumour cross section than indicated by the FET uptake.

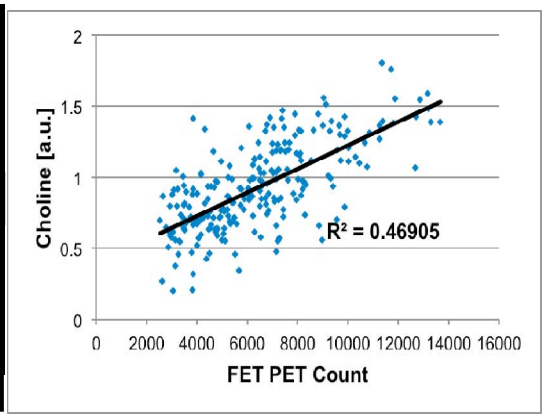

Figure 2: This example of an anaplastic oligodendroglioma grade III shows higher FET uptake correlated with increased choline.

Results: In n=18 out of 20 cases FET uptake data and spatially resolved whole brain MR spectroscopy data sets could be simultaneously acquired (Fig. 1). The dynamic analysis of the FET uptake classified 9 cases low-grade and 9 subjects high-grade. The line width <=13 Hz of the spectra was sufficient to calculate the respective metabolite maps, which show the spatial distribution of NAA, choline, myo-inositol, lactate and the corresponding normalised information. Lactate was increased in one subject of each group. The low-grade gliomas comprised 8 cases with increased choline and decreased NAA levels. Three subjects showed elevated myo-inositol, two had lowered levels. All high-grade gliomas revealed reduced NAA and increased myo-inositol. Choline was elevated in 6 cases and constant in 3 subjects. The correlation plots between voxel wise FET uptake values and metabolites detected by short echo time MRSI showed no clear association throughout all cases (Fig. 2).

Discussion: The successful acquisition of both modalities has been shown. The BrainPET insert does not significantly lower the magnetic field homogeneity. The findings of a higher number of cases with elevated choline levels in low-grade tumours and higher number of subjects with increased myo-inositol in high-grade tumours is in contrast to the literature [5].

Conclusions: More cases need to be examined to reach the significance level. The spatial distribution of metabolites and the delineation and the spread of differently malignant parts of gliomas based on the FET uptake can be investigated.

References: **[1]** Pauleit et al. *Brain* 128, 678-687, 2005. **[2]** Zeng et al. *Magn Reson Imag* 29, 25-31, 2011. **[3]** Ebel et al. *MRM* 53, 465-469, 2005. **[4]** Maudsley et al. *NMR Biomed* 19, 492-503, 2006. [5] Hattingen et al. *NMR in Biomed* 21, 233-241, 2007