

High Field 3 Tesla MRI and Positron Emission Tomography Detection of Malformations of Cortical Development in Refractory Focal Epilepsy

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INTRODUCTION: Malformations of cortical development (MCD) are an important cause of refractory focal epilepsy. The published prevalence of MCD in refractory epilepsy ranges from 8-12%. These studies were however conducted on 1.5 tesla (T) MRI scanners. The recent advent of clinical high field (3T) systems with multiple-channels leading to parallel-imaging capabilities has enabled faster clinical imaging. It is now possible to fully utilise the gain in signal-to-noise ratio at 3T to increase the spatial resolution of anatomical scans, while keeping the total acquisition time within clinically relevant limits. This is especially important in patient studies, in which long scan times are a source of potential failure due to motion-related corruption of the dataset. The use of newer high-resolution isovoxel MR datasets enables multi-planar post-processing of data. The prevalence of MCD may thus have been underestimated at lower field strength systems. Positron emission tomography (PET) was also not used as an ancillary tool. Our aim was to ascertain the prevalence of MCD in refractory focal epilepsy using high field 3T MRI and PET.

METHODS: Patients aged 16-65 years with medically refractory focal epilepsy were recruited. They were classified as refractory if they had tried and failed at least 2 antiepileptic drugs at maximum tolerated doses, and if they still had 2 or more seizures a month for the past 2 years.

MRI was performed using a clinical 3T whole body system (Achieva, Philips Medical Systems, Eindhoven, The Netherlands) using a dedicated epilepsy protocol. Conventional T2 and FLAIR sequences were performed, with coronal sections orthogonal to the long axis of the hippocampus. Optimised 3D magnetisation-prepared rapid acquisition with a gradient echo (MPRAGE) sequences with an isovoxel whole-brain sub-millimetre acquisition (0.9x0.9x0.9mm) in the axial plane using parallel imaging (SENSE) technology was also performed with the following parameters : TR/TE//FA/IR 8.4/3.8/8/860, FOV 230, matrix 256x256, 0.9 mm thickness, no gap, 192 z-phase encoding steps, 1 NEX, SENSE factor 2, scan time 5'14". The axial high resolution datasets were reformatted into sagittal, coronal and oblique planes as needed.

MRIs were independently reviewed by 2 neuroradiologists experienced in epilepsy neuroimaging; they were provided only information about semiology and EEG, and blinded to all other data, including prior neuroimaging. Disagreement was resolved by consensus.

If the MRI was interpreted as normal, a 18 fluorodeoxyglucose (FDG) PET scan was performed. Areas of hypometabolism were re-examined on the MRI using multiplanar reformatting (MPR).

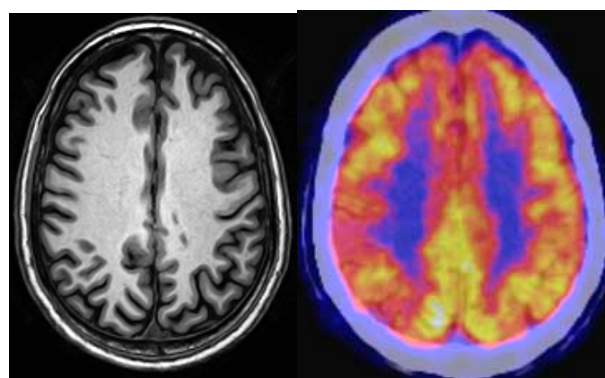


Fig. 1: R parietal hypometabolism due to underlying focal cortical dysplasia (a) left, axial MPRAGE image, (b) right, corresponding PET scan

RESULTS : Forty patients (22 female) were recruited; mean age 42.1 +/- 9.6 years. The duration of epilepsy was 8.2 +/- 6.2 years, seizure frequency was 3.1 +/- 2.8 per month.

MRI identified a lesion in 30/40 patients initially. PET was performed for 10/40 patients. MRI MPR after review of PET data allowed identification of a lesion in 1 additional patient. Of the 31 patients with a lesion after MRI and PET scans, 14 showed hippocampal sclerosis (12 unilateral, 2 bilateral), 8 showed gliosis, 3 showed benign tumours (1 ganglioglioma, 1 glioma, 1 DNET). Six were found to have MCD - 2 polymicrogyria, 2 focal cortical dysplasia (FCD), 2 periventricular heterotopia. In 1 patient with subtle FCD this was identified only after PET and multiplanar reformatting was performed.

CONCLUSION: The use of high field 3T scanners with parallel imaging technology in clinical practice offers the advantage of reducing overall scan time, thereby reducing the potential for motion artefacts, while achieving a high spatial resolution suitable for morphometry and multiplanar reconstructions. MCD is not uncommon and was seen in 15% of our cohort. The combination of MRI and PET imaging allows identification of MCD, especially subtle cortical dysplasia.

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