

## Imaging of Focal Cortical Dysplasia at 7 Tesla

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**Introduction:** Intractable epilepsy is a serious health condition with high impact on socio-economic performance. For some patients with this condition surgery is a therapeutic option. Success rate of surgery improves if a lesion can be identified on MRI and can be removed completely [1]. It is believed that the vast majority of patients with cryptogenic localization-related epilepsy have a focal cortical dysplasia (FCD) that is not seen on conventional MRI. 20-30% of FCD's found after surgical resection are MRI-negative [2]. Also, according to noninvasive neurophysiologic data as well as peroperative acute corticography data, it is likely that the epileptogenic zone and therefore probably the FCD extends beyond the lesions that are seen at 3T MRI [3]. Imaging at higher field strengths has been found to aid in diagnosis when comparing 1.5T to 3T [4]. Conceivably, scanning at 7T could be of benefit to patients in whom 3T MRI failed to adequately demonstrate a lesion. However, no data is currently available on the imaging features of FCD at 7T. Therefore, in this pilot study we analyzed appearance and extent of lesions seen at 3T and thought to be FCD type II, which is characterized histologically by dysmorphic neurons and is the most prominent type of FCD found with MRI.

**Method:** Included were 13 patients aged 20 to 48 with known localization-related epilepsy in whom previous 3T MRI showed signs of FCD. This study was approved by the local Medical Ethics Committee; all patients signed the informed consent form after explanation of goal, procedure and possible complications. Prior to the 7T exam, 3T MRI was performed using a state of the art epilepsy protocol (3D-T1, T2, T2\*, IR, FLAIR, Philips Medical Systems, Best, Netherlands) and seen by an experienced neuroradiologist in a specialized epilepsy centre (PH). Scanning at 7T was performed on 11 subjects (7 male, 4 female). The 7T images were acquired on a Philips 7.0T Achieva (Philips Healthcare, Cleveland, Ohio) using a 32-channel receive head coil. Used sequences were 3D T1 (TR 4.2 ms, TE 1.88 ms, voxel 0.9x0.9x0.9mm), 3D FLAIR (TR 7900 ms, TE 300 ms, TI 2200 ms, voxel 0.85x0.85x0.85mm), T2TSE (TR 3000 ms, TE 58 ms, voxel 0.5x0.5x1mm) and T2\*/SWI (TR 1764 ms, TE 25ms, voxel 0.24x0.24x1 mm). Total scan time was approximately 40 minutes. The 7T images were compared to the 3T images by a neurologist (AC). Detectability was assessed and borders were inspected. Structure as seen on 7T images was described and compared to the homologue contralateral region. The presence and appearance of the lesions was confirmed by an independent neuroradiologist (MvB).

**Results:** In 9 of 9 analyzed patients 7T showed improved visibility of the FCD compared to 3T in T2-weighted and FLAIR images (example in figures 1&2). At 7T detection of the FCD was easiest in FLAIR. After determining the exact location of the FCD, T2-w and T2\*-w MRI showed microstructural details of the lesion more clearly than the 3T scans (figure 3). Of all sequences, T1 was the least informative when detecting, locating and analyzing FCD's, both at 3T and at 7T. Demarcation of the FCD was considered sharper at 7T than at 3T and the extent of the abnormalities larger in 7 of the 9 patients. Accentuation of a hypointense band in the FCD creating a typical three layer flag-like appearance was best appreciated on T2-weighted images (fig. 3). Of the 13 included patients, two patients were excluded because upon thorough questioning they failed to meet the 7T inclusion criteria. 7T MRI revealed a vascular disorder in one patient. Reviewing the 3T MRI led to change of the original report. The treating physician was informed. The data were excluded from further analysis. The scan of one patient could not be analyzed due to severe motion artifacts.

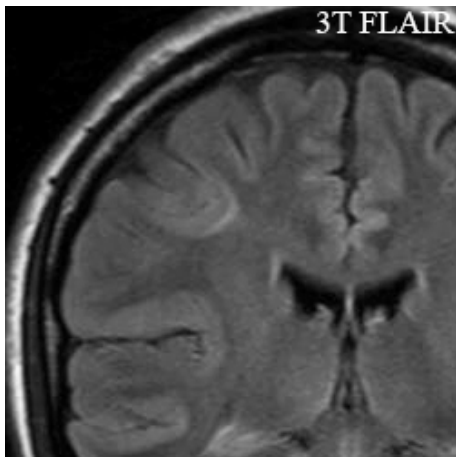


Fig. 1: coronal FLAIR image at 3T showing FCD with abnormal subcortical white matter signal.

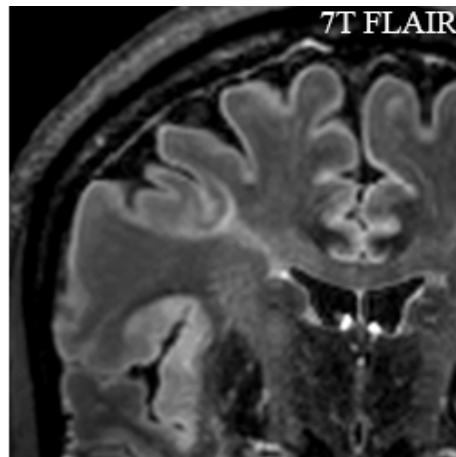


Fig. 2: coronal FLAIR image at of the same lesion at 7T. Subcortical hyperintensity, including 'tail' to the ependymal surface of the ventricle, is more pronounced.

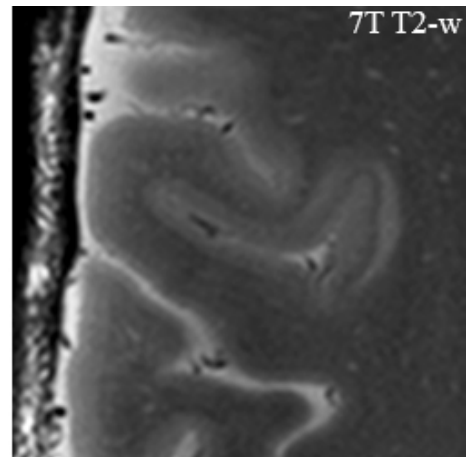


Fig. 3: transverse T2-weighted image of the same lesion at 7T showing cortical structure with high detail.

**Discussion and Conclusion:** In this pilot study it is shown that in vivo 7T brain imaging is feasible in epileptic patients and may have added value over 3T imaging. In patients with FCD type II, lesions were easier to detect and showed an increased area of pathology at 7T compared to 3T, with FLAIR being the most useful sequence in this respect. Structural features of FCD type II are more easily visible at 7T than at 3T, especially on T2- and T2\*-weighted images. For FCD of yet uncertain type this remains to be investigated. The next step will be investigating the use of 7T imaging in patients who are suspected of having FCD, but are MRI-negative at 3T.

**References:** [1] Bien C.G. et al. (2009) Archives of Neurology 66: 1491–9. [2] Tassi L. et al. (2002) Brain 125: 1719–32. [3] Blenkman A. et al. (2012) Epilepsy Research 98, 223–23110. [4] Phal P.M. et al. (2008) American Journal of Roentgenology 2008 191(3):890-5.