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EDITORIAL

**Roland Wiest**
**Barbara Schauble**

# The role of MRI in localisation of epileptogenic foci: how far have we come?

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R. Wiest (✉)
Institute for Diagnostic and Interventional Neuroradiology,
University Hospital of Berne, Inselspital, Berne, Switzerland
E-mail: roland.wiest@insel.ch

B. Schauble
Section of EEG and Epileptology, Department of Neurology,
University Hospital of Berne, Inselspital, Berne, Switzerland
E-mail: barbara.schaeuble@insel.ch

During the last decade, MR imaging has changed dramatically, from identification of gross structural abnormalities to in-depth analysis of "cryptogenic lesions"— their anatomical extent as well as their functional significance.

Newly developed MR methods such as voxel based morphometry (VBM) have expanded our knowledge about partial epileptic syndromes. For example, structural involvement of the entorhinal cortex in mesial temporal epilepsy [7] (TLE)—the most common cause of refractory epilepsy—was recently identified. Ongoing seizures seem to correlate with progressive mesial temporal atrophy as demonstrated in longitudinal MR [4]. In addition, development of neocortical atrophy is related to seizure frequency, interpreted as seizure-induced neuronal loss, as well as involvement of extensive neocortical neuronal networks [3].

Malformations of cortical development (MCD) are increasingly recognised as pathological substrate, and are currently the second most common cause for refractory partial epilepsy in adults. These lesions are hardly visible in routine MRI, but voxel-based 3-D MRI has the potential to increase the sensitivity to detect a MCD [5] by more than 30%. Whilst grey-matter abnormalities are preferentially delineated by VBM, associated white-matter changes are probably best depicted by diffusion tensor imaging (DTI). DTI provides information about the directionality and magnitude of the molecular motion of water, and is a promising method for delineating the extent of a cortical dysplasia into white matter [6].

The article "Evaluating functional MRI procedures for assessing hemispheric language dominance in neurosurgical patients" by Baciu and colleagues in this issue highlights the significance of functional neuroimaging in the presurgical evaluation of refractory epilepsy patients.

FMRI has been widely used to identify eloquent areas in order to prevent language and memory impairment after removal of the epileptogenic focus. The authors have used four different language paradigms to delineate eloquent regions in patients with partial epilepsies. The sensitivity of two different methods quantifying the HLD were investigated. These results were subsequently compared to various tests, such as WADA, electrocortical stimulation and surgical outcome as gold standards. By using the lateralisation index instead of predefined average magnitude measures of the BOLD signal, concordant fMRI predictions of HLD were achieved in 73% of all patients. According to Baciu et al. [2] the most sensitive parameter for HLD-fMRI is a semantic association task, which showed a 100% concordance with the WADA test in a small number of patients. An earlier study by this group used a fMRI rhyme-detection paradigm with similar results, which appears to be well suited for determining hemispheric language predominance in epileptic candidates for surgery. However, it seems questionable whether one single task can delineate all essential language areas sufficiently [8]. A single verbal fluency fMRI study proved to be less reliable in neocortical epilepsy than in TLE [10]. Comprehensive language paradigms may therefore be more suited for estimating language localisation and networks neighbouring removable brain lesions. In addition to HLD, memory lateralisation in TLE patients is essential for preoperative planning of anterior temporal resection and, at the individual subject level, has positive predictive value for memory decline in TLE patients [9].

Many promising tools emerge at this point, for example fMRI with simultaneously-recorded epileptiform discharges on EEG (spike-triggered fMRI and continuous EEG/fMRI recordings). The method might be useful to guide invasive EEG grid placement by exploring the irritative zone in focal epilepsies, even in the absence of structural abnormalities on conventional MRI [1]. In light of the fact that the irritative zone frequently extends beyond the ictal onset zone, further studies are needed to clearly delineate its value in the presurgical workup.

Other functional imaging techniques, e.g., ictal subtraction SPECT (SISCOM) or PET coregistered with structural MRI, have clearly improved patient outcome after resective surgery for refractory epilepsy by delineating the ictal onset zone as well as associated networks.

Functional neuroimaging is a safe, reliable and cost-effective tool to demonstrate pathologies which are associated with partial epilepsies, and to serve as a screening tool to guide and perhaps replace invasive neurophysiological approaches in the future.