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Editorial

Advances in pediatric epilepsy neuroimaging

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Epilepsy is a chronic brain disorder defined by recurrent seizures. Onset may occur early in life, and in fact most often occurs in childhood. The diagnosis and management of childhood epilepsy is more challenging than in adults, in part because of the rich diversity of underlying etiologies ranging from early cerebral anoxia, infection, metabolic disorders, developmental brain malformations, to those also found in young adulthood including hippocampal sclerosis, vascular malformations, primary brain neoplasms, and traumatic brain injury. Neuroimaging plays an important role in identifying the specific underlying pathology and in guiding treatment, and also provides information necessary for etiologic diagnosis, such as in various epilepsy syndromes, and hence prognosis for the affected child and family.

Magnetic resonance imaging (MRI) is the most important noninvasive imaging modality, and is mandated in the pre-surgical evaluation of children with epilepsy together with electroencephalography (EEG). Several series have documented that complete lesional resection is the best predictor for favorable postsurgical outcomes. While structural MRI provides exquisite anatomic delineation because of its high spatial resolution and intrinsic soft tissue contrast, it also has its limitations. For instance, MRI may fail to identify subtle lesions that account for up to 20–30% of refractory partial epilepsy, often related to subtle focal cortical dysplasia with microdysgenesis only revealed on histopathology. The identification of these lesions may be possible with other imaging modalities such as positron emission tomography (PET) or, in some instances, diffusion tensor imaging. In addition, in multifocal or diffuse diseases (such as in tuberous sclerosis), even though structural abnormalities can be sensitively depicted by MRI, it may be difficult to determine which of the lesions are epileptogenic and therefore targeted for surgical intervention. In such cases, additional information afforded by advanced MRI or physiologic imaging techniques including diffusion weighted imaging (DWI), MR spectroscopy, and single photon emission computed tomography (SPECT) or PET may be useful. Pre-surgical localization of these lesions, surgical planning and predicting outcome is therefore best accomplished by a multi-modality approach, incorporating structural, functional and physiologic techniques (including functional MRI [fMRI], and magnetoencephalography [MEG]) in addition to the EEG.

To date, many of the advanced physiological and functional imaging modalities have not been extensively validated in the evaluation of childhood epilepsy, and they therefore are not part of routine pre-surgical evaluation of such patients in many institutions. They do, however, hold immense promise. For example, incorporation of fMRI may allow refinement of surgical resection

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by identifying eloquent cortical regions and language lateralization, prognostication of functional outcomes, and monitoring of neurodevelopmental plasticity post surgery. When combined with concurrent EEG, fMRI may also allow the determination of both ictal and interictal brain activity. Another new and exciting noninvasive technique is near infrared spectroscopy (NIRS), which measures hemodynamic response in conjunction with simultaneous EEG recording. NIRS similarly allows language mapping, localization of epileptogenic zone, and assessment of cerebral reorganization, and is uniquely suited for both children who are cognitively or developmentally challenged, as well as for the very young (including neonates).

The time is now ripe to review neuroimaging methods beyond conventional, structural imaging, and provide an update of the recent advances in the field of imaging of pediatric epilepsy. In this issue, each chapter is devoted to a specific imaging technique, aiming to provide a basic understanding of the underlying principles, recommend specific protocols for pediatric epilepsy imaging, and review the current clinical applications. Advantages, challenges and limitations of each technique in the imaging of children with epilepsy are discussed. Ultimately, the use of advanced imaging techniques is hoped to reduce the need for invasive intracranial EEG and other procedures, and to improve outcome in cases treated by surgery or other means.