

FUNCTION IN CORTICAL MALFORMATIONS

Functional Organization of the Brain with Malformations of Cortical Development

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We examined the localization of cerebral functions in 28 patients with focal epilepsy and malformations of cortical development (MCDs). Polymicrogyria occurred in nine, hemimegalencephaly in four, heterotopia in eight, and focal cortical dysplasia (FCD) in nine cases. We used simple (sensorimotor, visual) or complex (language, memory) functional magnetic resonance imaging (fMRI) paradigms. Two thirds of MCDs were activated by simple fMRI paradigms, whereas they less frequently showed activity during complex cognitive fMRI paradigms. During simple paradigms, all disturbances of cortical organization (polymicrogyria, schizencephaly, and mild-type FCD) showed activity, whereas other MCDs (disturbances of earlier steps of cortical development: hemimegalencephaly, Taylor-type FCD, and heterotopia) showed activity in only 44% ($P < .01$). The association between the pathophysiology and morphology of MCDs confirms the recently proposed classification system. Both focal neurological signs ($P < .05$) and focal electroencephalogram slowing ($P < .05$) independently correlated with MCD inactivity, confirming that fMRI showed neuronal functions of MCDs. Conclusively, fMRI visualizes the MCD functions and their relations to the eloquent cortex, providing useful information before epilepsy surgery. Surgery for cortical organization disturbances should be cautiously performed because these malformations may participate to some degree in brain functions.

patients with MCD by using functional magnetic resonance imaging (fMRI). It is unclear from prior reports how many MCDs are activated by various experimental paradigms and what factors, such as type of MCD, influence the rate of activation. The present investigation reveals that a majority of MCDs are activated by simple sensorimotor or visual tasks, and this rate is increased in eloquent cortical regions. All MCDs resulting from disturbances of cortical organization exhibit fMRI activations to simple tasks, but fMRI activations were seen only in a minority of MCDs caused by disturbances of neuronal proliferation and migration. Thus the mildest disorders of cortical development, which arise during the last steps of cortical maturation, are more likely to have functionally active tissue compared with more severe MCDs, which arise at earlier stages of development. fMRI activation was less likely for more complex tasks, such as language or memory. For example, only four of the 10 patients with mild MCDs had activation on the more complex tasks.

Absence of fMRI activation was independently correlated with focal neurologic deficits and focal electroencephalogram (EEG) slowing. The authors conclude that this finding confirms that fMRI activations of MCDs reveal that they have neuronal function and that fMRI is a useful tool in the presurgical evaluation of patients with MCDs. As with any surgery for focal epilepsy, resection of MCDs should be approached with consideration of the function of the tissue to be removed. However, it is unclear exactly how the fMRI activations in MCDs will predict postoperative deficits. Unlike preoperative evaluations that mimic the effects of the planned resections by producing inactivation of tissue (e.g., focal electrical stimulation or intracarotid amobarbital), assessments that produce activation, such as fMRI, may not predict postoperative deficits because activation procedures reveal tissue that is involved in a task but may not reveal which tissue is necessary for the task. Resection of activated areas may not result in a deficit, and resection of areas that are not activated may produce a deficit. Thus fMRI cannot be used alone to predict postoperative deficits based on the present data. Additional fMRI studies of MCDs, conducted in association with inactivation procedures and with postoperative follow-up, will be needed to determine fully the ability of fMRI to predict postoperative deficits on an individual patient basis. Nevertheless, the study by Jansky et al. makes a significant contribution and sets the stage for future studies.

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COMMENTARY

Malformations of cortical development (MCDs) are the most common epileptogenic lesions in focal extratemporal epilepsy. Jansky et al. examined fMRI activation in 28 patients with focal epilepsy and MCDs. This is an important study because it is the largest and most systematic series to examine