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## 21.1 Introduction

FDG–PET is a well-established functional imaging modality in the evaluation of pediatric patients with epilepsy [1, 12]. While ictal scans can be useful, the long duration required to reach steady-state glucose uptake (on the order of many minutes compared with partial seizures, which usually last <2 min) often leads to scans that contain a difficult-to-interpret mixture of

interictal, ictal, and postictal states. In addition, the practical realization of an ictal FDG–PET study requires the coordination of radiotracer availability with the ictal event, which is difficult to assure. Consequently, ictal PET studies are rarely performed, and ictal SPECT perfusion studies are preferred instead. However, if ictal injection is feasible, ictal PET images may clearly depict the cortical area responsible for the epileptic event (Fig. 21.1).

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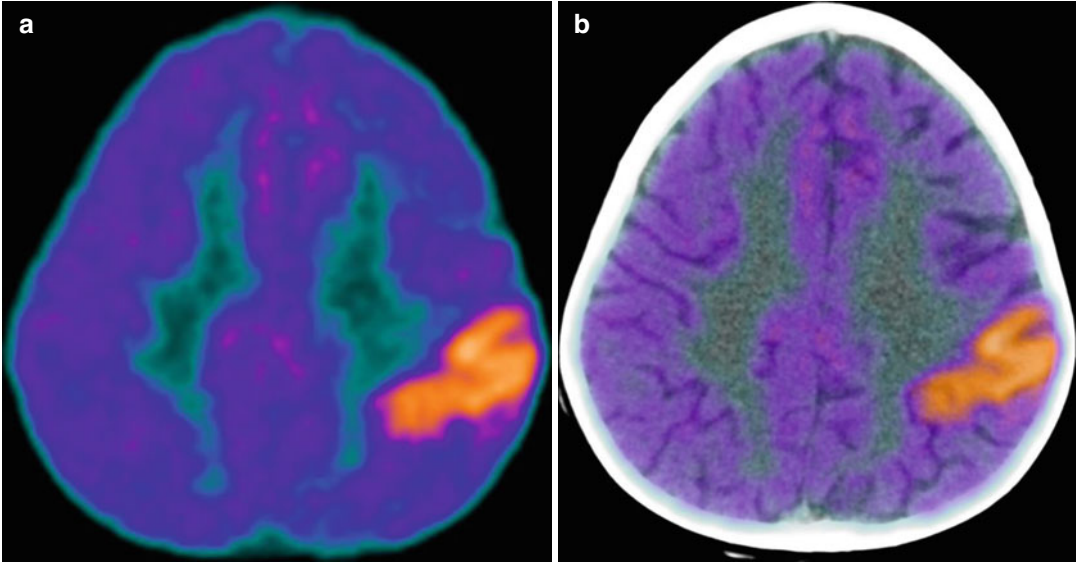
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Presurgical FDG–PET scans in epilepsy patients are typically obtained when the patient is in the interictal state, with the goal of detecting focal areas of decreased metabolism, i.e., relative hypometabolism, as these presumably

reflect focal functional disturbances of cerebral activity associated with epileptogenic tissue. Nonetheless, the specific cause of hypometabolism in and near epileptogenic regions of the brain remains unclear [3].



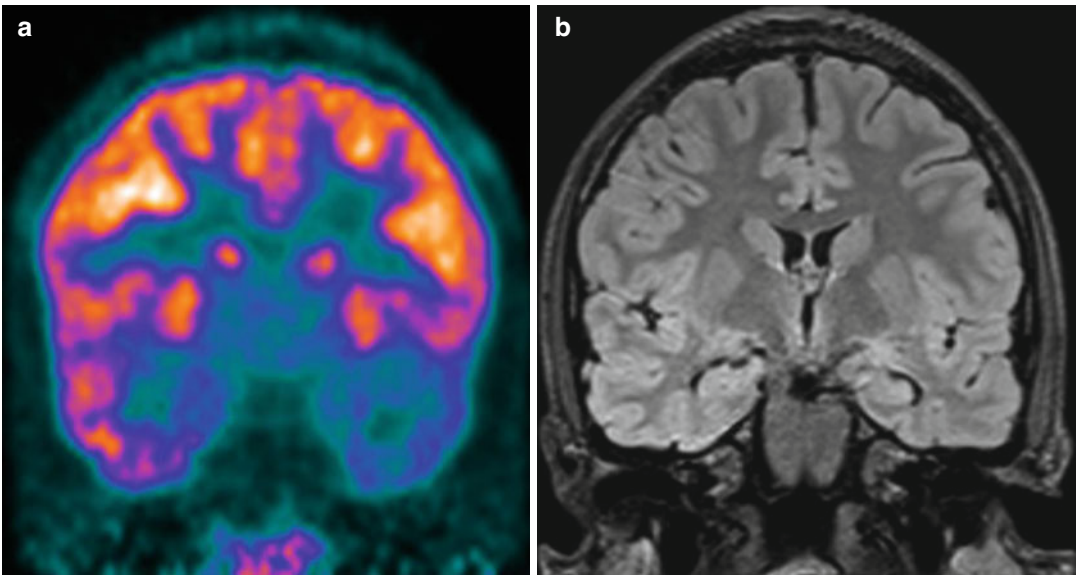
**Fig. 21.1** A 5-year-old girl with Rasmussen's encephalitis and partial seizures since the age of 3 years. (a) Axial PET image, (b) PET/MRI fusion. FDG was fortuitously

administered during a seizure and shows, with very high spatial resolution and excellent image contrast, the involved cortex in the left hemisphere

## 21.2 FDG-PET in Temporal Lobe Epilepsy

The value of FDG-PET has been best proven in the evaluation of medically refractory epilepsy patients who are candidates for surgery, specifically those with clinically suspected temporal lobe epilepsy. In this setting, the sensitivity of FDG-PET is between 80 and 90 % [1–4]. Only a few studies have addressed the sensitivity and specificity of FDG-PET in medial temporal

lobe epilepsy patients with and without evidence of hippocampal sclerosis on MRI. However, FDG-PET is still considered to be reliable in lateralizing the epileptogenic temporal lobe even in MRI-negative patients, as shown in Fig. 21.2 [5]. Of course, MRI techniques are constantly evolving, and new sequences and new analytical approaches may one day allow the identification of focal alterations in cases previously considered to be “MRI negative.”



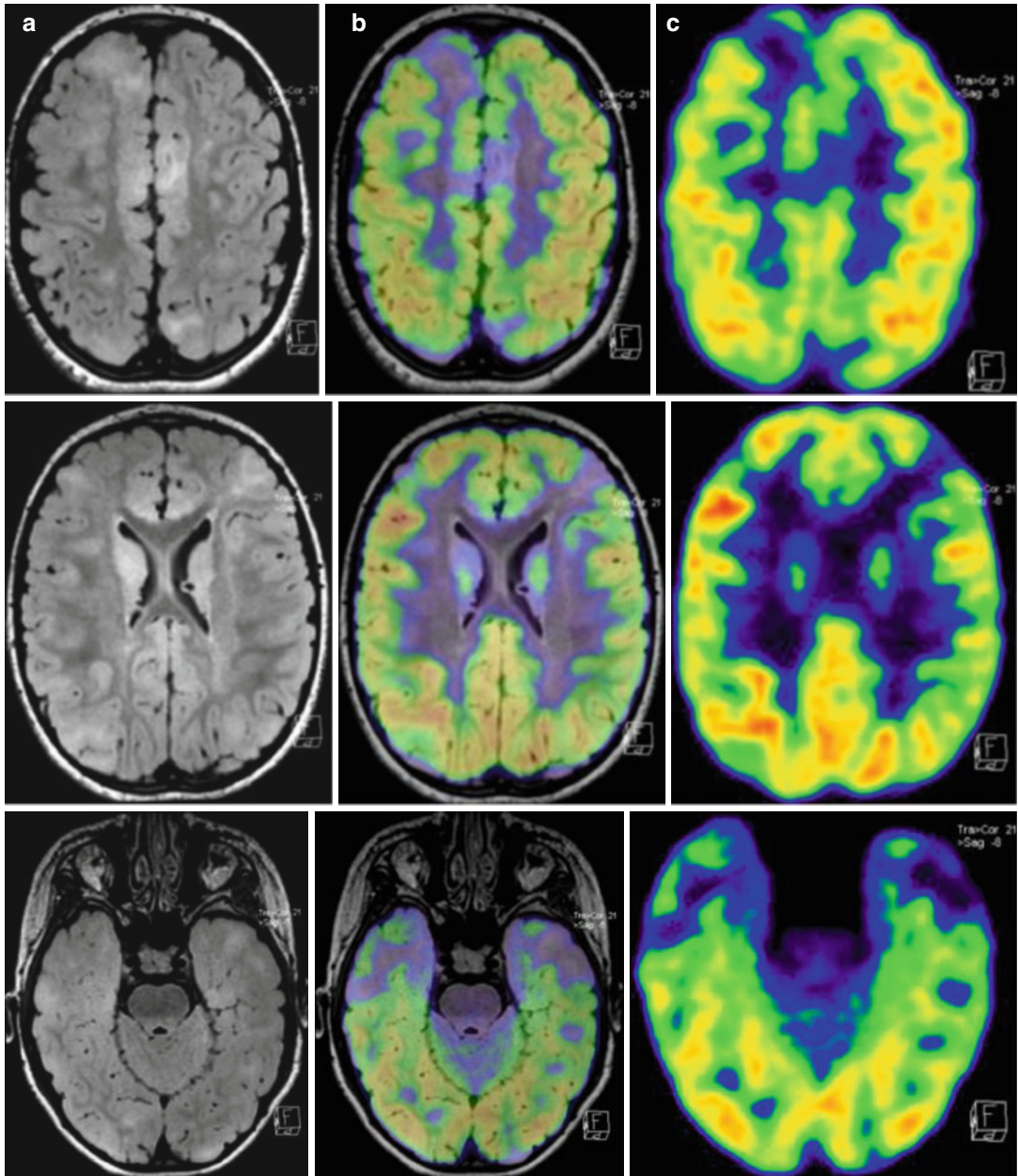
**Fig. 21.2** A 13-year-old boy with partial complex epileptic seizures. **(a)** Coronal PET image, **(b)** MRI image. MRI does not show any clear abnormality, while on the PET image, there is marked hypometabolism in the left

temporal pole. A repeated MRI investigation identified an area of probable cortical dysplasia. A left anterior temporal lobectomy was planned

### 21.3 FDG-PET in Extratemporal Epilepsy

The clinical value of FDG-PET in neocortical epilepsy is less clear. The larger reported series consist of observational retrospective studies, and only a few were performed in the era of

advanced MRI techniques [1, 6]. Most importantly, the FDG-PET findings in nonlesional neocortical epilepsy are often obtained from heterogeneous patients and patient groups. An example of the FDG pattern in a specific syndrome such as tuberous sclerosis is provided in Fig. 21.3 [7].



**Fig. 21.3** A 5-year-old girl who at the age of 5 months was diagnosed with tuberous sclerosis and generalized epileptic seizures. (a) Axial MRI, (b) PET/MRI fusion, and (c) PET images. The PET/MRI fusion images show multiple cortical lesions in the two hemispheres, typically

hypometabolic on FDG-PET imaging. However, these imaging modalities do not allow localization of the lesion generating the epileptic seizures. Instead, promising results were obtained using  $\alpha$ -[ $^{11}\text{C}$ ]methyl-L-tryptophan (AMT), a tracer specific for the serotonergic system



In tuberous sclerosis typically FDG-PET shows hypometabolism in and around tubers, believed to be due to decreased neuronal number and simplified dendritic pattern. A tuber with a disproportionately large area of hypometabolism compared with its size on MR images is most likely epileptogenic [8]. However, both epileptic and nonepileptic tubers show reduced uptake on FDG-PET, while promising results have been obtained using a tracer specific for the serotonergic system, the  $\alpha$ -[11C]methyl-L-tryptophan (AMT). AMT-PET shows increased AMT uptake interictally in epileptic but not quiescent tubers in almost two-thirds of children with tuberous sclerosis and intractable epilepsy: all tubers with at least 10% AMT increase were found to be epileptogenic [11].

Co-registered multimodality imaging may provide other supportive localizing information confirming that a questionable PET metabolic abnormality is indeed a true disturbance reflective of the epileptogenic zone, thus emphasizing the added value of imaging fusion or hybrid imaging, when available [9, 13, 14].

## 21.4 Other PET Tracers

Many tracers have shown promising results in the molecular imaging of epilepsy, especially those targeting the GABAergic system ( $^{11}\text{C}$ -flumazenil), the serotonergic system ( $^{11}\text{C}$ -WAY and  $\alpha$ - $^{11}\text{C}$ -methyl-L-tryptophan), the dopaminergic system, the glutamatergic system, nicotinic receptors, adenosine receptors, and opioid-based ligands. However, these tracers, mostly based on carbon-11 chemistry and on the availability of an on-site cyclotron, are still limited to dedicated research centers, and their description is beyond the scope of this chapter. The results obtained with these tracers were recently summarized in two reviews [10, 11, 12].

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