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Excitotoxic Mechanism in Pediatric Brain

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Purpose
The way the brain responds to traumatic stimulation, prolonged seizures, and hypoxia with the release of excitatory amines, such as glutamate and glutamine, is different in infants, children, and adults. Such excitotoxic mechanisms also are related to some neurodegenerative diseases in pediatric patients. This exhibit illustrates various diseases associated with excitotoxic mechanisms in the pediatric brain on CT and MR imaging including diffusion-weighted imaging and MR spectroscopy (MRS).

Materials & Methods
We reviewed CT and MR findings in over 100 pediatric patients with diseases associated with excitotoxic mechanisms, including battered child syndrome, diffuse axonal injuries, periictal encephalopathy, crossed cerebellar diaschisis related to recurrent seizure, Rasmussen encephalitis, infarction, hypoxic ischemic encephalopathy, mitochondrial encephalopathy, herpes encephalitis, congenital HIV-1 encephalopathy, and Rett syndrome.

Results
In battered child syndrome, the distribution of parenchymal injury was found not to be related to the vascular territories or the location and size of acute subdural hematomas on CT and MR imaging. This type of parenchymal injury might be mainly due to excitotoxic mechanisms. In status epileptics, the lesions were found in the hippocampus, cingulate gyrus, thalamus, and cerebellum. They presumably are related to the distribution of N-methyl-D-aspartate type glutamate receptors. These lesions may result primarily from an excitotoxic mechanism mediated by intrinsic neuronal seizure activity. In one patient, MR imaging showed signal abnormalities in the cerebral cortex and contralateral cerebellum after repetitive seizures. This finding represents seizure-related transsynaptic excitotoxic cell damage. In Rasmussen encephalitis, CT and MR imaging showed progressive destruction of a single cerebral hemisphere. Its pathogenesis is thought to be due to glutamate receptor autoimmunity associated with persistent viral infection. Excitotoxicity also might play a major role in HIV-induced neurodegeneration and Rett syndrome. Diffusion-weighted imaging is useful to detect early ischemic changes especially in water-rich pediatric brain tissues. MRS shows glutamate peaks in patients with battered child syndrome, status epilepticus, and herpes encephalitis.

Conclusion
Excitotoxic mechanisms play an important role in various diseases in pediatric patients. We illustrate their imaging findings and discuss the pathophysiology of the excitotoxic mechanisms.
Glutamate receptor antagonists may offer attractive possibilities for future therapy in these diseases.