Neurologic Emergencies in Pediatric Patients Including Accidental and Nonaccidental Trauma

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KEYWORDS

• Accidental injury • Calvarial fractures • Nonaccidental injury • Meningitis • Encephalitis • Subdural empyema • Cerebral venous sinus thrombosis • Arterial stroke

KEY POINTS

- Traumatic and non-traumatic neurologic emergencies can be seen in children.
- Imaging is determined by the level of neurologic status and suspected etiology.
- Pearls, pitfalls and variants in imaging in various conditions are highlighted in this article.

INTRODUCTION

In neurologic emergencies in children, neuroimaging is very often needed because of the limitations in gathering an accurate history as well as difficulties with performing the neurologic examination. In such a situation, the challenge for the physician is in deciding (1) if an imaging test is required emergently and (2) what is the most appropriate imaging test. The causes of neurologic emergencies in pediatric patients are numerous (**Box 1**). Specific entities that are common and unique to pediatric patients are discussed, with an emphasis on pearls and pitfalls for the radiologist as well as the referring physician.

GUIDELINES FOR IMAGING

There are differences that characterize optimal imaging in pediatric patients in comparison with adults. Part of this due to different disease processes that occur in children, some of which can be congenital. Age is often a factor when deciding the appropriateness of an imaging test. Children are more sensitive to the harmful effects of radiation; therefore, MR imaging is the preferred modality for imaging in older children when sedation does not need to be administered. Longer scanning times for MR imaging are generally required for sedation in younger children, generally younger than 6 years. Computed tomography (CT) may be considered as a first choice of imaging, rather than magnetic resonance (MR), if it can provide the necessary information.

INDICATIONS FOR CHOICE OF MODALITY

CT is considered the modality of choice in situations when determination of etiology needs to be done emergently, because of deteriorating neurologic status secondary to suspected hemorrhage during trauma, and in uncooperative patients. CT is also very useful for detection of calcifications, bony structures, and before a lumbar puncture to rule out a mass or bleeding. MR imaging is superior to CT in the evaluation of epilepsy, known tumors, white matter pathology, and infection/inflammation in the brain. MR imaging is generally

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Box 1
Causes of neurologic emergencies in the pediatric population

- Nontraumatic
  - Infection
    - Meningitis
    - Encephalitis (HSV)
    - Subdural empyema
  - Acute hydrocephalus
  - Stroke
    - CVST
    - Arterial stroke
    - HIE
  - Metabolic
    - Amino acid/urea cycle disorders
  - Toxic
    - Methotrexate-induced encephalopathy
    - Cyclosporine-induced PRES
  - Neoplastic
  - Epilepsy
  - Others: ADEM
- Traumatic
  - Accidental
  - Nonaccidental

Abbreviations: ADEM, acute disseminated encephalomyelitis; CVST, cerebral venous sinus thrombosis; HIE, hypoxic ischemic encephalopathy; HSV, herpes simplex virus; PRES, posterior reversible encephalopathy syndrome.

performed without contrast, except in cases of a known brain tumor or when suspicion for a tumor is very high, ataxia, and when suspecting infection. When evaluating for vascular pathology, MR angiography is preferred in children to avoid radiation exposure; but CT may be indicated in specific conditions, such as vasculitis. A fast MR imaging scan, consisting of 1 or 2 sequences, is now used, instead of CT, in many institutions for the evaluation and follow-up of hydrocephalus. Most children who present with headaches do not require any advanced neuroimaging. Neuroimaging should be reserved for children who have an abnormal neurologic examination (eg, ataxia, papilledema, or diplopia), new-onset thunderclap headache, associated with morning vomiting or failure in improvement after 4 weeks of symptomatic treatment.

NONTRAUMATIC

Infection

Meningitis

Meningitis is an infectious/inflammatory infiltration of the leptomeninges (pia and arachnoid mater), which can be acute (bacterial or viral) or chronic (tuberculosis or fungal).[1] The infection can be spread hematogenously, via local infection (eg, sinusitis, mastoiditis, or orbital cellulitis) or directly via implantation.[2] Patients may present with a severe headache, neck stiffness, fever, photophobia, and altered mental status.[3]

Meningitis is associated with leptomeningeal enhancement. Although dural enhancement can be seen normally, leptomeningeal enhancement is considered abnormal.[4] Normal enhancement of the dura is thin, markedly discontinuous, and most prominent in the parasagittal regions. It appears symmetric and does not usually extend into the sulci. Meningeal enhancement due to meningitis is seen extending to the base of the sulci and is asymmetric.[5] The pattern of leptomeningeal enhancement in bacterial and viral meningitis is thin and linear, whereas it is thick, lumpy, and nodular in fungal meningitis.[6] Acute meningitis will manifest with pathologic enhancement over the cerebral convexity, whereas chronic meningitis enhances most prominently in the basal cisterns.[2]

Only 50% of patients show imaging features consistent with meningitis and the diagnosis of meningitis is made clinically with cerebrospinal fluid (CSF) cultures. The primary role of imaging is to exclude increased intracranial pressure before lumbar puncture, to rule out meningitis mimickers, and to evaluate for any complications of meningitis.[7,8]

An initial CT or MR imaging early in the disease process may appear normal; progression of the disease may reveal mild hydrocephalus and loss of the gray-white matter differentiation, suggesting cerebral edema on a noncontrast CT. In severe cases, obliteration of the CSF spaces and basal cisterns with exudate can be seen. MR imaging has the advantage of increased sensitivity for the detection of enhancement in the subarachnoid spaces.[9] The exudate will appear isointense on T1 and hyperintense on T2/fluid-attenuated inversion recovery (FLAIR) images and may demonstrate restricted diffusion.[9] Postcontrast MR imaging is best for observing leptomeningeal involvement[10,11] (**Fig. 1**A, B). Postcontrast FLAIR imaging is superior in sensitivity to postcontrast T1-weighted imaging in the detection of early abnormal meningeal enhancement.[11] T1 postcontrast images, on the other hand, are more sensitive in the detection of parenchymal enhancement.[10]