

**American College of Radiology
ACR Appropriateness Criteria®**

Clinical Condition: Headache—Child

Variant 1: Isolated headache (unaccompanied by neurologic signs and symptoms or historical data).

| Radiologic Procedure | Rating | Comments | RRL* |
|--|--------|----------------------|----------------------------------|
| CT head without contrast | 2 | | High |
| CT head with contrast | 2 | | High |
| CTA head | 2 | | High |
| MRI head without contrast | 2 | | None |
| MRI head with contrast | 2 | | None |
| MRA head without contrast | 2 | | None |
| INV arteriography cerebral | 2 | Not an initial test. | High |
| Rating Scale: 1=Least appropriate, 9=Most appropriate | | | *Relative Radiation Level |

Variant 2: Headaches with positive neurologic signs or symptoms.

| Radiologic Procedure | Rating | Comments | RRL* |
|--|--------|--|----------------------------------|
| CT head without contrast | 8 | CT or MRI should be performed in every patient. | High |
| MRI head without contrast | 8 | CT or MRI should be performed in every patient. | None |
| MRI head with contrast | 7 | See comments regarding contrast in text under “Anticipated Exceptions.” | None |
| CTA head | 6 | Indicated if subarachnoid or parenchymal blood is identified on CT, MRI, or LP. Either CTA or MRA, not both. | High |
| MRA head without contrast | 5 | Indicated if subarachnoid or parenchymal blood is identified on CT, MRI, or LP. Either CTA or MRA, not both. | None |
| CT head with contrast | 3 | | High |
| INV arteriography cerebral | 2 | Not an initial test. | High |
| Rating Scale: 1=Least appropriate, 9=Most appropriate | | | *Relative Radiation Level |

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Clinical Condition:**Headache—Child****Variant 3:****Acute severe (thunderclap) headache and absence of family history of migraine.**

| Radiologic Procedure | Rating | Comments | RRL* |
|--|---------------|--|----------------------------------|
| CT head without contrast | 9 | CT or MRI should be performed in every patient. | High |
| MRI head without contrast | 8 | CT or MRI should be performed in every patient. | None |
| MRA head without contrast | 7 | Indicated if subarachnoid or parenchymal blood is identified on CT, MRI, or LP. Either CTA or MRA, not both. | None |
| CTA head | 7 | Indicated if subarachnoid or parenchymal blood is identified on CT, MRI, or LP. Either CTA or MRA, not both. | High |
| INV arteriography cerebral | 6 | If MRA or CTA not available or if intervention is considered. | High |
| CT head with contrast | 2 | | High |
| MRI head with contrast | 2 | | None |
| Rating Scale: 1=Least appropriate, 9=Most appropriate | | | *Relative Radiation Level |

Variant 4:**Migraine with or without aura (without neurologic findings).**

| Radiologic Procedure | Rating | Comments | RRL* |
|--|---------------|----------------------|----------------------------------|
| CT head without contrast | 2 | | High |
| CT head with contrast | 2 | | High |
| CTA head | 2 | | High |
| MRI head without contrast | 2 | | None |
| MRI head with contrast | 2 | | None |
| MRA head without contrast | 2 | | None |
| INV arteriography cerebral | 2 | Not an initial test. | High |
| Rating Scale: 1=Least appropriate, 9=Most appropriate | | | *Relative Radiation Level |

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HEADACHE—CHILD

Expert Panel on Pediatric Imaging: Jeffrey Scott Prince, MD¹; Richard Gunderman, MD, PhD²; Brian D. Coley, MD³; Ellen R. Blatt, MD⁴; Dorothy Bulas, MD⁵; Lynn Fordham, MD⁶; Boaz K. Karmazyn, MD⁷; Daniel J. Podberesky, MD⁸; Charles Paidas, MD⁹; William Rodriguez, MD.¹⁰

Summary of Literature Review

Headache is very common in children. The prevalence of headaches in patients age 7 years of age or younger is 19%-51%, with migraine representing 1%-5% [1,2]. In large cross-sectional studies, 60% of children 7 to 15 years of age suffered from headaches, and 3%-4% suffered from migraines [1,2]. In a U.S. study, the prevalence of headaches in adolescents was 56% for boys and 74% for girls, with migraines accounting for 3.8% and 6.6%, respectively [3].

The majority of pediatric headaches are benign. Imaging in these patients shows a low rate (0.9%-1.2%) of significant findings. The majority of imaging studies in patients with headache are normal [4,5]. Occasionally, headache heralds the development of a brain tumor or other structural abnormality in a child. However, the annual incidence of brain tumor in the pediatric age group approximates only three per 100,000 (0.003%) [6]. The need to distinguish headaches due to other causes from headaches due to structural abnormalities presents a major dilemma. A review of the literature finds that most articles on this subject are retrospective case series. Reviews from pediatric neurology or pediatric neurosurgical referrals bias the data when evaluating structural anomalies associated with headache. Similar bias comes from retrospective reviews provided through large brain tumor consortiums. It is difficult to assess the health outcome of early detection of any intracranial lesions, because the type, size, and location determine their management. These issues are not unique to the pediatric patient; they have also been discussed in a series of adult literature reviews [7]. Clinical experience of primary care physicians, pediatricians, and neurologists indicates that neuroimaging studies have a limited role in children with headaches [8-17].

The high prevalence of headaches and the low yield of imaging in pediatric patients presenting with headaches alone bring into question the value of screening for patients with “isolated” headaches. There are, however, clinical conditions that influence the yield of positive examinations. Numerous studies, most of which are retrospective, help identify those findings or clinical characteristics that, when associated with headaches, appear to be useful predictors of positive imaging evaluation and therefore influence the appropriateness of imaging. There are no data to support imaging a child with an isolated headache unaccompanied by neurologic signs, presence of a seizure, or supporting patient historical data.

Headaches with Positive Neurologic Signs or Symptoms

Major studies addressing the issues of brain tumors and indications for imaging—including the data from 3,291 children described in the Childhood Brain Tumor Consortium [6], 315 children in the Boston Children’s review [18], and 72 children in the data of Honig and Charney [19]—suggest that nearly all children with intracranial tumors had symptoms or neurologic signs accompanying their headache. The data from the Childhood Brain Tumor Consortium [6] and the Honig and Charney study [19] showed that 94% of children with brain tumors had abnormal neurologic findings at diagnosis and 60% had papilledema. Other neurological findings included gait disturbance, abnormal reflexes, cranial nerve findings, and altered sensation. Medina et al [18] identified papilledema, nystagmus, and gait disturbances as univariant predictors of brain tumor. Confusion and other assorted abnormal neurological findings were multivariant predictors of brain tumors. It would appear appropriate from these retrospective data to consider intracranial imaging in any patient presenting with headache and positive neurologic findings.

Supporting Patient Historical Data

There also appear to be specific patient historical data or headache characteristics that are associated with intracranial pathology [5,20]. Headaches that awaken the child from sleep or occur on arising appear to have clinical significance [19]. Intense, prolonged, and incapacitating headaches with an absent family history for migraine may indicate an underlying pathology. Patients with headaches increasing in frequency, duration, and intensity might benefit from imaging. Vomiting accompanied headaches in 78% of patients in the study by Honig and Charney [19], and it was also predictive of pathological process in the study by Medina et al [18]. Individuals who have these specific historical data of headache characteristics may benefit from neuroimaging.

¹Principal Author, Primary Children’s Medical Center, Salt Lake City, Utah; ²Panel Chair, Riley Hospital for Children, Indiana University, Indianapolis, Ind; ³Panel Vice-chair Columbus Children’s Hospital, Columbus, Ohio; ⁴The Children’s Hospital, Denver, Colo; ⁵Children’s National Medical Center, Washington, DC; ⁶University of North Carolina, Chapel Hill, NC; ⁷Riley Hospital for Children, Indiana University, Indianapolis, Ind; ⁸Wilford Hall Medical Center, Lackland Air Force Base, Tex; ⁹Tampa General Hospital, Tampa, Fla, Pediatric Surgical Association; ¹⁰ The Office of Pediatric Therapeutics in the Office of the Commissioner, US Food and Drug Administration, Rockville, MD, American Academy of Pediatrics (The views expressed are those of the author and do not necessarily reflect or represent endorsement by the US Food and Drug Administration).

Reprint requests to: Department of Quality & Safety, American College of Radiology, 1891 Preston White Drive, Reston, VA 20191-4397.

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Sudden Severe Headache (Thunderclap Headache)

Sudden severe headaches are more common in adults than in children. These “thunderclap headaches” are associated with subarachnoid and intracranial hemorrhage that may occur with aneurysms or arteriovenous malformations. Although childhood intracranial aneurysms are rare [21], many case reports document severe acute headache as the presenting symptom [21,22]. Sudden severe unilateral headaches in the pediatric population and in young adults correlate with carotid or vertebral dissection, especially when associated with neurologic signs and symptoms. In sudden severe headaches, particularly in the absence of a family history of migraine, neuroimaging with a computed tomography (CT) scan without contrast has been advocated [23]. If subarachnoid or parenchymal hemorrhage is detected, further evaluation for aneurysm or vascular malformation must be performed. This can be accomplished by CT angiography (CTA) or MR angiography (MRA). If a malformation is not detected by either of these methods, catheter angiography should be considered. Catheter angiography may provide more definitive information regarding a vascular lesion and may also be considered for neurovascular intervention.

Migraine with or without Aura

By 15 years of age, 3% to 10% of children experience migraine headaches [1-3,24,25]. There is a female predominance. In 1988 the International Headache Society described two types of migraine: migraine with aura (classic), and migraine without aura (common) [26]. It reported that 17% of patients with migraine headaches had an accompanying aura. The most common associated symptoms are nausea, vomiting, abdominal pain, and disturbance of vision. Visual symptoms include scintillating scotomata, blurriness, transient hemianopia, or complete blindness in one eye (amaurosis fugax) [8,16]. A family history of the disorder can be elicited in more than half of patients [27]. Other symptoms include numbness and tingling in one arm or over an entire side, hemiplegia, aphasia, or apraxia.

Clinicians can have difficulty distinguishing the first, second, or third migraine headache from headache caused by brain tumor, subarachnoid hemorrhage, vasculopathy, arteriovenous malformation, or other underlying disease processes [28]. These patients may be imaged before the diagnosis of migraine is established. One of the clues in differentiating these headaches may relate to transient neurologic findings versus persistent findings in tumor headaches. In a study of 72 patients with brain tumor headaches [19] abnormal physical signs were present in 94%.

Migraine may have many manifestations. If there is a pattern to the headaches it is usually not difficult to diagnose. Children with migraines are symptom-free between headaches. If the child has typical migraine with

or without aura, most clinicians would recommend no imaging studies [9,14,17,18,29]. No imaging is also recommended in cases of common migraine of more than 6 months duration [8,18] in patients with a family history of migraine and in nonprogressive migraine attacks [8,18].

Complicated Migraine (Those with Neurologic Deficit)

Because the presenting signs and symptoms of complicated migraines with focal neurologic findings cannot be discriminated from similar presentations related to intracranial neoplasms, imaging is recommended [8,18]. In ophthalmologic migraine with focal neurologic symptoms of unilateral ptosis or complete third-nerve palsy, imaging is recommended to exclude other intracranial abnormalities [18].

In patients with miscellaneous migraine findings or syndromes such as vertigo, basilar artery migraine syndrome, persistent confusion migraine syndrome, progressive chronic headache, or hemiplegic migraine, imaging may be appropriate to exclude an aneurysm, a space-occupying lesion, or other intracranial abnormality.

Sinogenic Headache

Sinus disease may present with headache or may be associated with it. The diagnosis of acute sinusitis in children is made clinically; however, in children who present with severe and persistent headache as the dominant feature of sinusitis, imaging may be warranted [30-33]. Clinical signs suggesting intracranial abnormality include high fever, confusion, and change in mental status with and without focal signs. Headache is the most common symptom identified with the intracranial spread of infection resulting from dural irritation and localized encephalitis. Occasionally, patients who present with various primary headache syndromes without significant nasal or sinus symptoms and fail to respond to conventional therapy are found to have evidence of sinusitis on CT [34].

Epidural empyemas are collections of suppurative fluid located between the skull and dura. They are less prevalent in young children than in adolescents [32]. The most common underlying abnormality is paranasal sinusitis. The differential diagnosis includes meningitis, subdural and subarachnoid bleeding, and brain abscess. Imaging is decisive and aids treatment. The diagnostic choice is either CT or magnetic resonance imaging (MRI). Contrast enhancement can increase the conspicuousness of a subtle collection. MRI may be preferable for diagnosing epidural empyemas because of its ability to distinguish between different types of fluid [35].

Trauma

Clearly, intracranial imaging plays a critical role in the evaluation of the acutely injured patient; however,

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because headache is rarely a major indication for imaging, in the context of this Appropriateness Criteria[®] topic, we will consider only the evaluation of headache related to subacute or remote trauma.

Patients who have a history of subacute or remote trauma may present with headaches. Currently, there is no published series evaluating headaches that correlate neurologic signs and symptoms with imaging findings. However, in adults the complaint of headache has been associated with an increased risk of intracranial injury, even in patients suffering minor head trauma with Glasgow coma scores greater than 13. Thus, in children who have had previous minor head trauma and who are awake and alert with no neurological deficit, the indications for CT or MRI are not clear. Certainly, it would be prudent to consider imaging of patients in whom neurologic signs or symptoms are positive, whose headaches are associated with vomiting, or whose headaches are increasing in frequency, duration, or severity, regardless of the severity of the initial trauma.

Headache with Fever or Known Underlying Disease

Headache may accompany a febrile illness. Additional testing may be required when meningitis or encephalitis is suspected. Neurologic signs and symptoms such as nuchal rigidity or alteration in consciousness may be indications for imaging. In addition, there are known underlying disease processes that predispose patients to intracranial pathology. Children with underlying disease—such as immunocompromised patients, children with known neoplasms, sickle cell patients, and patients with coagulopathy or hypertension—are predisposed to intracranial pathology. In high-risk groups, the presence of a severe headache may indicate significant intracranial pathology. It would seem appropriate to consider a lower threshold for imaging in this patient population.

Anticipated Exceptions

Nephrogenic systemic fibrosis (NSF), also known as nephrogenic fibrosing dermopathy) was first identified in 1997 and has recently generated substantial concern among radiologists, referring doctors and lay people. Until the last few years, gadolinium-based MR contrast agents were widely believed to be almost universally well tolerated, extremely safe and non-nephrotoxic, even when used in patients with impaired renal function. All available experience suggests that these agents remain generally very safe, but recently some patients with renal failure who have been exposed to gadolinium contrast agents (the percentage is unclear) have developed NSF [36-38], a syndrome that can be fatal. Further studies are necessary to determine what the exact relationships are between gadolinium-containing contrast agents, their specific components and stoichiometry, patient renal function and NSF. Current theory links the development of NSF to the administration of relatively high doses (eg,

>0.2mM/kg) and to agents in which the gadolinium is least strongly chelated. The FDA has recently issued a “black box” warning concerning these contrast agents (http://www.fda.gov/cder/drug/InfoSheets/HCP/gcca_200705HCP.pdf).

This warning recommends that, until further information is available, gadolinium contrast agents should not be administered to patients with either acute or significant chronic kidney disease (estimated GFR <30 mL/min/1.73m²), recent liver or kidney transplant or hepato-renal syndrome, unless a risk-benefit assessment suggests that the benefit of administration in the particular patient clearly outweighs the potential risk(s) [37].

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria[®] [Radiation Dose Assessment Introduction](#) document.

| Relative Radiation Level Designations | |
|---------------------------------------|-------------------------------|
| Relative Radiation Level | Effective Dose Estimate Range |
| None | 0 |
| Minimal | < 0.1 mSv |
| Low | 0.1-1 mSv |
| Medium | 1-10 mSv |
| High | 10-100 mSv |

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