

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

Clinical Condition:

Headache

Variant 1:

Worsened chronic headache. History of headache.

Radiologic Procedure	Rating	Comments	RRL*
MRI head without and with contrast	4		None
CT head without contrast	4		Med
CT head without and with contrast	4		Med
MRI head without contrast	4		None
MRA head	2		None
INV arteriography cerebral	2		Med
NUC Tc-99m HMPAO SPECT head	2		High
CTA head	2		Med
US transcranial	1		None
FDG-PET head	1		High
<u>Rating Scale:</u> 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Variant 2:

Sudden onset of severe headache (“Worst headache of one's life, thunderclap headache”).

Radiologic Procedure	Rating	Comments	RRL*
CT head without contrast	9		Med
CTA head	8		Med
MRA head	8		None
INV arteriography cerebral	7		Med
MRI head without contrast	7	May be helpful after CT depending on CT findings.	None
MRI head without and with contrast	6	May be helpful after CT depending on CT findings.	None
CT head without and with contrast	6		Med
US transcranial	2		None
NUC Tc-99m HMPAO SPECT head	2		High
FDG-PET head	1		High
<u>Rating Scale:</u> 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

An ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those exams generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

Clinical Condition:

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Variant 3:

Sudden onset of unilateral headache, or suspected carotid or vertebral dissection or ipsilateral Horner's syndrome.

Radiologic Procedure	Rating	Comments	RRL*
CTA head and neck	8	Usage of CT versus MRI depends on local preference and availability.	Med
MRA head and neck	8	Usage of CT versus MRI depends on local preference and availability.	None
MRI head without and with contrast	8	With diffusion-weighted sequences.	None
CT head without contrast	8		Med
MRI head without contrast	8	With diffusion-weighted sequences.	None
INV arteriography cerebral	7		Med
CT head without and with contrast	6		Med
US carotid duplex	3		None
NUC Tc-99m HMPAO SPECT head	2		High
US transcranial	2		None
FDG-PET head	1		High
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Variant 4:

Headache, suspected complication of sinusitis and/or mastoiditis.

Radiologic Procedure	Rating	Comments	RRL*
MRI head without and with contrast	8		None
CT head without contrast	7	Include sinuses.	Med
MRI head without contrast	7		None
CT head without and with contrast	6	Include sinuses.	Med
X-ray head	4		Min
US transcranial	2		None
NUC Tc-99m HMPAO SPECT head	1		High
FDG-PET head	1		High
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Clinical Condition:

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Variant 5:

New headache in patient older than age 60. Sedimentation rate higher than 55, temporal tenderness. Suspected temporal arteritis.

Radiologic Procedure	Rating	Comments	RRL*
MRI head without contrast	8	With diffusion-weighted sequences.	None
MRI head without and with contrast	7	With diffusion-weighted sequences.	None
CT head without contrast	6		Med
CTA head and neck	5		Med
MRA head and neck	5		None
CT head without and with contrast	5		Med
INV arteriography cerebral	4	If noninvasive imaging unrewarding.	Med
US transcranial	2		None
NUC Tc-99m HMPAO SPECT head	1		High
FDG-PET head	1		High
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Variant 6:

New headache in HIV+ individual.

Radiologic Procedure	Rating	Comments	RRL*
MRI head without contrast	8		None
MRI head without and with contrast	8		None
CT head without contrast	6	If MRI not available.	Med
CT head without and with contrast	5		Med
MRA head	3	If vascular lesion suspected.	None
CTA head	3	If vascular lesion suspected.	Med
US transcranial	2		None
FDG-PET head	2	Useful if indeterminate mass present.	High
NUC Tc-99m HMPAO SPECT head	2	Useful if indeterminate mass present.	High
INV arteriography cerebral	2	If noninvasive imaging non-rewarding.	Med
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Variant 7:

New headache in pregnant patient.

Radiologic Procedure	Rating	Comments	RRL*
MRI head without contrast	8		None
CT head without contrast	8		Med
MRI head without and with contrast	5	Pregnancy is a relative contraindication to gadolinium administration. Reserve for urgent medical necessity.	None
MRA head	5	MR venography (MRV) should also be performed.	None
CT head with contrast	3	For urgent medical necessity only.	Med
CTA head	2	If MRI not available, contraindicated or inconclusive.	Med
US transcranial	1		None
NUC Tc-99m HMPAO SPECT head	1		High
FDG-PET head	1		High
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Variant 8:

New headache. Suspected meningitis/encephalitis.

Radiologic Procedure	Rating	Comments	RRL*
MRI head without and with contrast	8		None
CT head without contrast	8	To exclude intracranial pressure.	Med
MRI head without contrast	6	Needs contrast.	None
MRA head	6	MRV should also be performed.	None
CT head without and with contrast	6	MRI preferable, depending on availability.	Med
CTA head	3	Useful for problem solving or if there is a strong suspicion of vascular disease.	Med
US transcranial	1		None
NUC Tc-99m HMPAO SPECT head	1		High
FDG-PET head	1		High
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

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HEADACHE

Expert Panel on Neurologic Imaging: John E. Jordan, MD¹; David J. Seidenwurm, MD²; Patricia C. Davis, MD³; James A. Brunberg, MD⁴; Robert Louis De La Paz, MD⁵; Pr. Didier Dormont⁶; David B. Hackney, MD⁷; John P. Karis, MD⁸; Suresh Kumar Mukherji, MD⁹; Patrick A. Turski, MD¹⁰; Franz J. Wippold II, MD¹¹; Robert D. Zimmerman, MD¹²; Michael W. McDermott, MD¹³; Michael A. Sloan, MD, MS.¹⁴

Summary of Literature Review

Headache is one of the most frequent ailments of the human race. Studies of the prevalence of headache: of any kind in populations have estimated frequencies of 11%-48% in children [1,2] and 6%-71% in adults [3,4]. As with migraine, age, gender, and case definition may largely account for this variance [5]. However, a higher prevalence of headache has been found by surveys in Europe and North America [6,7] than by those of Asian and South American countries [4,8]. A survey of the Canadian population showed that only about 20% of people there are headache free [9]. Prevalence of migraine shows a clear-cut gender difference, affecting about 15%-18% of women and 6% of men [5,10]. It occurs most commonly in men and women 25-55 years of age. Muscle contraction or tension accounts for most of the nonmigraine headaches encountered in population surveys.

By comparison, the frequency of pathology that can present with headache is rather small. The yearly incidence of brain tumors in the United States is 46 per 100,000. For subarachnoid hemorrhage, the yearly incidence is 9 per 100,000. Arteriovenous malformations (AVMs) are about one-tenth as frequent as saccular aneurysms. Only a subset of these patients presents with isolated headache. In a retrospective review of the presentation of 111 brain tumors, headaches were a symptom in 48%, equally for primary and metastatic brain tumors [11]. Headaches were similar to tension type in 77%, migraine-type in 9%, and other types in 14%. The typical headache was bifrontal but worse ipsilaterally, and was the worst symptom in only 45% of patients. Other studies have found a higher frequency, but sometimes the headache preceded the diagnosis of brain

tumor by several years, bringing up the possibility of an association with this common complaint, rather than causality [12,13]. In children with brain tumors, headache was present in 62%, more often with infratentorial tumors [14]. Because tumors are rare and only about half of them present with headache, it becomes apparent that if all patients with headache undergo imaging procedures, a large proportion of the studies will be negative [12].

Several studies have confirmed the low yield of imaging procedures in individuals presenting with isolated headache—that is, headache unaccompanied by other neurological findings [15,16]. Most of them are retrospective reviews. The patients were referred for imaging because the referring physician suspected pathology detectable by imaging or the patients requested the study to be certain that they did not have a brain tumor. A prospective review of 293 computed tomography (CT) scans ordered in an ambulatory family practice setting disclosed that most of them were ordered because the clinician suspected that a tumor (49%) or a subarachnoid hemorrhage (SAH) (9%) might be present. Fifty-nine (17%) were ordered because of patient expectation or medico-legal concerns [17].

Studies before 1991 on the yield of CT or magnetic resonance imaging (MRI) in patients with headache but normal neurological examination were reviewed by Frishberg [18]. Most of the larger ones were performed with first-generation CT. In addition, he included three more studies in his excellent meta-analysis [19-21]. Of 897 studies in patients with migraine, only four were positive, three for a tumor and one for an AVM, giving a 0.4% yield of potentially treatable lesions. In patients with unspecified headache, 1,825 scans yielded a total of 43 lesions (21 tumors, 8 hydrocephalus, 6 AVMs, 5 subdural hematomas, and 3 aneurysms), for a 2.4% yield of potentially treatable lesions. However, two studies in this group were performed at tertiary referral centers (the Mayo Clinic and the Cleveland Clinic) in the early days of CT and had a 500% higher rate of clinically important findings than more recent prospective studies [19,21]. If these two studies are not included among those performed in patients with unspecified headache, the total number of potentially treatable lesions is reduced to three in 725 studies (0.4%) [18]. A potential bias for the early series, however, is that the studies were performed with first-generation equipment, which was likely to have less sensitivity than currently used units.

Of 1,999 scans reported in other series, including mostly CT, only 21 (1%) disclosed treatable lesions [17,22-28]. Most of the positive cases occurred in the series of Becker et al [17], which included an unspecified number of patients with abnormal neurological findings. If this series is excluded from the analysis, only nine out of 1,999 patients (0.5%) had treatable findings. In a

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retrospective review of charts from 1,074 consecutive emergency department patients who underwent cranial CT, headache was associated with low yield of abnormality [29].

When considering such a common disorder as headache, the indications for the use of imaging procedures become particularly relevant. This is particularly true in view of the emerging and rapidly evolving technologies in use today [30-33]. In frequent conditions, performing low-yield studies is more likely to result in false positive results, with the consequent risk of causing additional and unnecessary procedures to be performed. As indicated above, the yield of positive studies in patients referred with isolated, nontraumatic headache is about 0.4%. In terms of cost, if one assumes the cost of a CT scan to be \$400 and an MRI to be \$900, to detect a lesion with CT would cost \$100,000 and with MRI, \$225,000.

One should not assume, however, that there is no social benefit in negative imaging studies in the setting of headache. Indeed, headache symptoms can be quite ominous and onerous to the one suffering them, and there can be tremendous costs with respect to productivity and quality-of-life issues. Moreover, health care providers perceive value in imaging headache when the fear of litigation is accounted for. While it is beyond the scope of this review to assess the factors and inherent value of negative imaging tests in headache imaging, it must be emphasized that costs of detection or screening in imaging headache are always overstated when the value of negative results are not factored into the analysis [15].

Some headache presentations require further discussion. A patient presenting with a sudden, severe headache (“the worst headache of my life”, “thunderclap headache”), particularly if it is not a migraine or if the pattern of the headache is clearly different from the patient’s usual headaches, is at a significantly higher risk of having an SAH, which is more often related to an aneurysm than to an AVM. In a combination of three series, as many as 165 of 350 patients (47%) presenting with thunderclap headache had an SAH [34-36]. If the CT scan is negative, a lumbar puncture should be performed to disclose additional instances of SAH [35,36]. These patients may require magnetic resonance angiography (MRA), computed tomography angiography (CTA), and/or catheter angiography to determine the nature and location of the lesion.

Sudden, severe unilateral headache in a young patient, particularly when it radiates into the neck and is accompanied by ipsilateral Horner's syndrome, may be the result of arterial dissection of the carotid or vertebral arteries [37]. In a series of 161 patients, headache was reported by 68% of them, and, when present, it was the initial manifestation in 47% of those with carotid dissection and in 33% of those with vertebral dissection [38]. Although some of these patients had stroke-like

syndromes, others did not, or they developed them several days after an initial presentation with isolated headache. The pattern of radiation will often differ enough to make the patient suspect that this is not a regular headache. In this case, MRI, MRA, CTA and/or catheter angiography are particularly useful to identify the nature of the lesion. Current practice is to anticoagulate these patients to prevent thrombosis at the site of the stenotic lesion. For this reason, identification of the pathology is important.

In 315 children with isolated headache scanned at Boston Children’s Hospital, 4% had surgical space-occupying lesions [39]. Sleep-related headache and no family history of migraine were the strongest predictors. The comments made above about selected populations referred to tertiary care centers apply to this example also.

Patients older than 55 years with new onset of headache in the temple regions, particularly when they have tender superficial temporal arteries, should be studied for temporal arteritis [40-42]. Treatment with steroids may forestall vision loss or brainstem strokes.

New onset of headache in populations predisposed to intracranial pathology also results in a much higher yield of findings by CT or MRI. For instance, a series of 49 HIV-positive individuals had an 82% yield of positive pathology. Although cryptococcal meningitis was most common (39%), toxoplasmosis was a close second (16%), and a number of patients had other mass lesions identified by CT [43]. Patients with known cancer should also be scanned when a headache develops or changes in characteristics [44,45]. In the Andes population, the rate of headache is low, whereas cysticercosis is common. As a result, CT of patients with headache yielded a 33% rate of positive studies [8].

In summary, screening patients with isolated, nontraumatic headache by means of CT or MRI is not warranted. However, for some types of headache or populations at risk these procedures are more likely to be positive. Thunderclap headaches, headaches radiating to the neck, and temporal headaches in an older individual are examples of headaches for which imaging procedures may be helpful. Patients with suspected meningitis and those presenting with headaches in pregnancy also often pose important diagnostic challenges [46-48]. HIV-positive individuals, cancer patients, or other populations at high risk of intracranial disease also should be screened when presenting with new-onset headaches.

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

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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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An ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those exams generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.