

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

Clinical Condition: Headache

Variant 1: Chronic headache. No new features.

Radiologic Procedure	Rating	Comments	<u>RRL*</u>
MRI head without and with contrast	4	See statement regarding contrast in text under "Anticipated Exceptions."	None
MRI head without contrast	4		None
CT head without contrast	4		Med
CT head without and with contrast	4		Med
MRA head with or without contrast	2		None
Arteriography cervicocerebral	2		Med
CTA head	2		Med
<u>Rating Scale:</u> 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Variant 2: Chronic headache with new features.

Radiologic Procedure	Rating	Comments	<u>RRL*</u>
MRI head without and with contrast	8	See statement regarding contrast in text under "Anticipated Exceptions."	None
MRI head without contrast	7		None
CT head without contrast	5	If new features highly suggestive of intracranial hemorrhage, see variant 3. If MRI unavailable or contraindicated.	Med
MRA head with or without contrast	5	Selected cases when vascular disease suspected. See statement regarding contrast in text under "Anticipated Exceptions."	None
CT head without and with contrast	4	If MRI unavailable or contraindicated.	Med
CTA head	4	Not generally appropriate for screening or first study. To be used in combination with CT. For problem solving.	Med
Arteriography cervicocerebral	2	Not used as a primary diagnostic tool.	Med
<u>Rating Scale:</u> 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Clinical Condition:

Headache

Variant 3:

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	Usage of CT vs MRI depends on local preference and availability.	Med
MRA head with or without contrast	8	Usage of CT vs MRI depends on local preference and availability. See statement regarding contrast in text under “Anticipated Exceptions.”	None
Arteriography cervicocerebral	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. See statement regarding contrast in text under “Anticipated Exceptions.”	None
CT head without and with contrast	6		Med
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Variant 4:

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 with or without contrast	8	Usage of CT versus MRI depends on local preference and availability. See statement regarding contrast in text under “Anticipated Exceptions.”	None
MRI head without and with contrast	8	With diffusion-weighted sequences. See statement regarding contrast in text under “Anticipated Exceptions.”	None
MRI head without contrast	8	With diffusion-weighted sequences.	None
CT head without contrast	7		Med
Arteriography cervicocerebral	7		Med
CT head without and with contrast	6		Med
US carotid duplex	3		None
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Clinical Condition: Headache

Variant 5: Headache, suspected intracranial complication of sinusitis and/or mastoiditis. (See the ACR Appropriateness Criteria® on “Sinonasal Disease”)

Radiologic Procedure	Rating	Comments	RRL*
MRI head without and with contrast	8	See statement regarding contrast in text under “Anticipated Exceptions.”	None
CT head without contrast	7	Sinus imaging may also be indicated.	Med
MRI head without contrast	7		None
CT head without and with contrast	6	Sinus imaging may also be indicated.	Med
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Variant 6: 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. See statement regarding contrast in text under “Anticipated Exceptions.”	None
CT head without contrast	6		Med
CTA head and neck	5		Med
MRA head and neck with or without contrast	5	See statement regarding contrast in text under “Anticipated Exceptions.”	None
CT head without and with contrast	5		Med
Arteriography cervicocerebral	4	If noninvasive imaging unrewarding.	Med
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Variant 7: New headache in HIV+ or immunocompromised individual.

Radiologic Procedure	Rating	Comments	RRL*
MRI head without contrast	8		None
MRI head without and with contrast	8	See statement regarding contrast in text under “Anticipated Exceptions.”	None
CT head without and with contrast	6		Med
CT head without contrast	5	If MRI not available.	Med
MRA head with or without contrast	5	Indicated if vascular lesion suspected. See statement regarding contrast in text under “Anticipated Exceptions.”	None
CTA head	5	Indicated if vascular lesion suspected.	Med
FDG-PET head	4	Useful if indeterminate mass present.	High
Tc-99m HMPAO SPECT head	2	Useful if indeterminate mass present.	High
Arteriography cervicocerebral	2	If noninvasive imaging unrewarding.	Med
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Clinical Condition:**Headache****Variant 8:****New headache in pregnant patient.**

Radiologic Procedure	Rating	Comments	<u>RRL*</u>
MRI head without contrast	8	Usage of CT vs MRI depends on local preference and availability.	None
CT head without contrast	8	Usage of CT vs MRI depends on local preference and availability.	Med
MRI head without and with contrast	5	Pregnancy is a relative contraindication to gadolinium administration. Reserve for urgent medical necessity. See statement regarding contrast in text under "Anticipated Exceptions."	None
MRA head with or without contrast	5	MR venography (MRV) should also be performed. See statement regarding contrast in text under "Anticipated Exceptions."	None
CT head with contrast	3	For urgent medical necessity only.	Med
CTA head	2	If MRI not available, contraindicated or inconclusive. CTV may also be performed.	Med
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Variant 9:**New headache. Suspected meningitis/encephalitis.**

Radiologic Procedure	Rating	Comments	<u>RRL*</u>
MRI head without and with contrast	8	Usage of CT vs MRI depends on local preference and availability. See statement regarding contrast in text under "Anticipated Exceptions."	None
CT head without contrast	8	Usage of CT vs MRI depends on local preference and availability. To exclude signs of increased intracranial pressure, mass, or mass effect.	Med
MRI head without contrast	6		None
MRA head with or without contrast	6	MRV should also be performed. See statement regarding contrast in text under "Anticipated Exceptions."	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
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

HEADACHE

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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, as well as genetic factors, affecting about 15%-18% of women and 6% of men [5,10,11]. 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 low. The yearly incidence of brain tumors in the United States is 46 per 100,000. For subarachnoid hemorrhage, the yearly incidence is nine 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 [12]. 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 [13,14]. In children with brain tumors, headache was present in 62%, more often with infratentorial tumors [15]. 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 [13].

Several studies have confirmed the low yield of imaging procedures in individuals presenting with isolated headache—that is, headache unaccompanied by other neurological findings [16,17]. 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 [18].

Computed Tomography and Magnetic Resonance Imaging

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 [19]. The scans examined in most of the larger studies were performed with first-generation CT equipment. In addition, Frishberg included three more studies in his excellent meta-analysis [20-22]. 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 [20,22]. 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%) [19]. 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.

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The American College of Radiology seeks and encourages collaboration with other organizations on the development of the ACR Appropriateness Criteria through society representation on expert panels. Participation by representatives from collaborating societies on the expert panel does not necessarily imply society endorsement of the final document.

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Of 1,999 scans reported in other series, mostly using CT, only 21 (1%) disclosed treatable lesions [18,23-29]. Most of the positive cases occurred in the series of Becker et al [18], 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 retrospective review of charts from 1,074 consecutive emergency department patients who underwent cranial CT, headache was associated with low yield of abnormality [30].

When considering such a common disorder as headache, the indications for the use of imaging procedures become particularly relevant. This is particularly true in the face of emerging and rapidly evolving technologies in use today [31-34]. 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 of 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 is not factored into the analysis [16].

Thunderclap Headache

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 [35-37]. If the CT scan is negative, a lumbar puncture should be performed to disclose additional instances of SAH [36,37]. 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.

Severe Unilateral Headache

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 [38]. 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 [39]. 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 the pain’s 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 [40]. Sleep-related headache and no family history of migraine were the strongest predictors. (See the ACR Appropriateness Criteria® on “Headache — Child.”) The comments made above about selected populations referred to tertiary care centers apply to this example also.

Temporal Headache

Patients older than 55 years with new-onset headache in the temple regions, particularly when they have tender superficial temporal arteries, should be studied for temporal arteritis [41-43]. Treatment with steroids may forestall vision loss or brainstem strokes.

Pregnant Patients

Patients presenting with headache in pregnancy may also have higher yields of a pathologic etiology. While guidance in this area is still limited, these patients appear to require careful consideration regarding neuroimaging, as a recent study found a 27% underlying etiology for headache in pregnant patients presenting to the emergency department [44].

Intracranial Pathology

New-onset 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 [45]. Patients with known cancer should also be scanned when a headache develops or changes in characteristics [46,47]. 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]. Although transcranial ultrasound (US), single-photon-emission CT (SPECT), and positron emission tomography (PET) are not currently routinely used in the evaluation of patients with headache, PET and SPECT may be useful in differentiating tumor from infection in high-risk patients.

Summary

- Screening patients with isolated, nontraumatic headache by means of CT or MRI is usually not

warranted, but in some cases imaging may be required depending on the clinical circumstances.

- 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 [44,48-50].
- HIV-positive individuals, cancer patients, or other populations at high risk of intracranial disease also should be screened when presenting with new-onset headaches.

Anticipated Exceptions

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (ie, <30 mL/min/1.73m²), and almost never in other patients. There is growing literature regarding NSF. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates <30 mL/min/1.73m². For more information, please see the [ACR Manual on Contrast Media](#) [51].

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

Supporting Document(s)

- [ACR Appropriateness Criteria® Overview](#)
- [Evidence Table](#)

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The 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 examinations 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.