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Headache

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This chapter discusses the diagnosis and imaging of headache. The chapter will follow the classification provided by the International Headache Society (IHS) (see www.i-h-s.org). The IHS uses the term "primary headache" to describe tension type, migraine, and cluster headaches, and "secondary headache" to describe headaches occurring secondary to another disorder. The three main points of this chapter are:

1. Most headaches represent one of three types of primary headaches, are diagnosed based on clinical features, and do not usually require imaging.
2. Secondary headaches may demonstrate "danger" signs which require immediate imaging and/or lumbar puncture.
3. Secondary headaches may rarely be insidious and mimic primary headaches.

MOST HEADACHES ARE PRIMARY HEADACHES, ARE DIAGNOSED BASED ON CLINICAL FEATURES, AND USUALLY DO NOT REQUIRE IMAGING

Primary care practitioners will see many patients with a chief complaint of headache. The diagnosis of primary headache, or headache which is not secondary to an anatomic cause, typically relies on clinical evaluation. Most primary headaches fall into one of three types: tension type headache, migraine headache, and cluster headache. Patients with chronic intermittent headaches usually do not require imaging, if there are no associated neurologic findings, if the pattern of headache is stable, and if the clinical features are characteristic of one of these types of headaches. Brief descriptions of the three common types of headache follow.

Tension type headache

To meet IHS criteria for tension type headache, the headache must last from 30 minutes to 7 days and have two of the following four characteristics: bilateral location, non-pulsating quality, mild to moderate intensity, and lack of aggravation by routine physical activity. The headache must also have no associated nausea or vomiting. The headaches may be associated with photophobia or phonophobia, but not both. Tension type headaches specifically lack auras, a feature of migraine headaches (see below).

Most patients with tension type headache do not seek medical care since they recognize the headache as temporary, self-limiting, and not particularly disabling[1]. Bendtsen and Jensen argue that infrequent episodic tension type headache is a normal phenomenon and not a disease per se[2]. Tension type headache apparently results from sensitized dorsal horn neurons misinterpreting innocuous stimuli as painful[3]. The diagnosis is based on the criteria listed above, and, absent any associated neurologic features or other unusual findings, imaging is not typically performed.

Migraine headache

To meet IHS criteria for migraine headache, the headache must last from 4 to 72 hours and have two of the following four characteristics: unilateral location, pulsating quality, moderate or severe intensity, and aggravation by routine activity. During the headache, the patient must have nausea and/or vomiting, or photophobia and/or phonophobia. Migraines may occur with or without auras; if without, 5 attacks meeting the above criteria

are necessary for diagnosis but if with auras, only 2 attacks are necessary. Auras consist of visual and/or sensory and/or speech symptoms characterized by gradual onset, duration of less than an hour, and complete reversibility[4]. Examples including seeing flickering lights or feeling a "pins and needles" sensation.

While migraine headaches are much less frequent than tension type headaches, patients are more likely to visit a primary care provider because of the severity of the headache. Because of the relative frequency and severity of migraine, almost all patients presenting to the primary care provider with severe episodic headaches are likely to have migraine headaches[5]. Severe migraines may be disabling and referral to a neurologist and/or headache specialist may be in order. Neurogenic inflammation causes migraine[5], and treatment is directed toward prevention or elimination of this inflammation. Patients meeting the above criteria for migraine headache do not typically require imaging unless there is a change of the headache pattern (Figure 1).

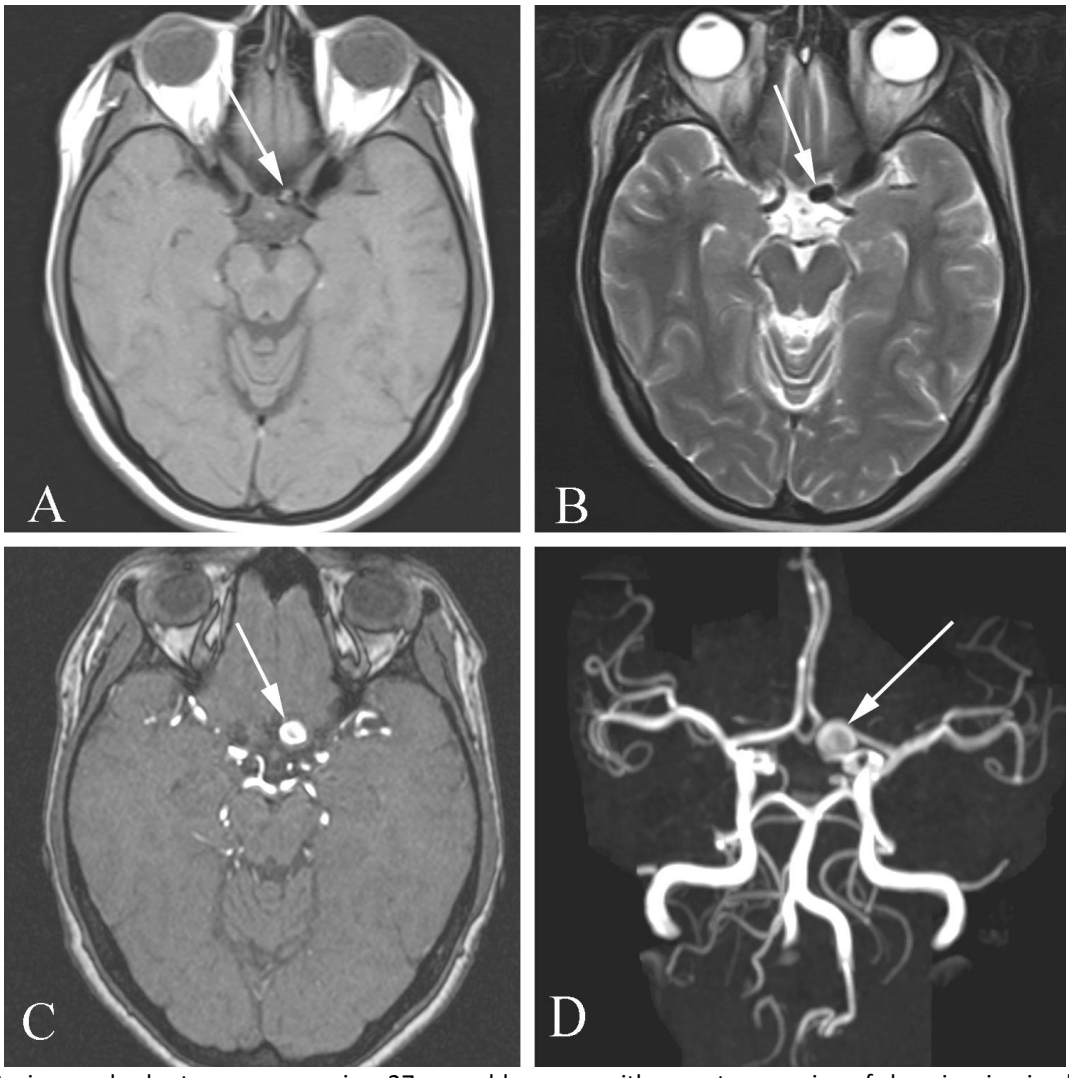

Figure 1. Anterior cerebral artery aneurysm in a 27 year old woman with recent worsening of chronic migraine headaches. A. Axial T1 weighted brain MR shows an aneurysm of the left anterior cerebral artery (arrow). B. Axial T2 weighted image shows the aneurysm as well (arrow). C. Axial source images from a magnetic resonance angiogram of the circle of Willis also show the aneurysm (arrow). D. 3D maximum intensity projection of the circle of Willis also shows the aneurysm (arrow).

Cluster headache

To meet IHS criteria for cluster headache, the headache must last from 15 to 180 minutes and have one of the following six characteristics: ipsilateral conjunctival injection and/or lacrimation; ipsilateral nasal congestion and/or rhinorrhea; ipsilateral eyelid edema; ipsilateral forehead and facial sweating; ipsilateral miosis and/or ptosis; or a sense of restlessness or agitation. The attacks must also have a frequency from one every other day to eight per day, with at least five such attacks in total (the term "cluster" refers to the tendency of the attacks to come in groups, frequently separated by longer periods without headache). Unlike patients with migraine headache who want to avoid movement, patients suffering with a cluster headache prefer to pace about[6].

Cluster headache is considerably less frequent than tension type headache and migraine headache, but is severe enough that most of these patients will seek medical care. Cluster headache is a subtype of a broader group of disorders known as trigeminal autonomic cephalgias with activation of the trigeminal-autonomic reflex causing the pain[6]. Unlike the situation with tension type headache and migraine headache, current recommendations are to perform imaging in patients with the initial diagnosis of cluster headache. This follows from the fact that a number of intracranial abnormalities have been reported to cause secondary cluster headache, and neuroimaging is necessary to exclude such causes as intracranial aneurysms, meningiomas, and pituitary tumors[7]. Magnetic resonance imaging of the brain performed without and with contrast, along with MRA of the circle of Willis, is the preferred imaging study in patients with the initial diagnosis of cluster headache.

SECONDARY HEADACHES MAY DEMONSTRATE "DANGER" SIGNS WHICH REQUIRE IMMEDIATE IMAGING AND/OR LUMBAR PUNCTURE FOR DIAGNOSIS

Most patients with "danger" signs requiring immediate diagnostic work-up (including CT and/or lumbar puncture) will come to the emergency room rather than the primary care provider's office. However, the evolution of health care has blurred the distinction between the ER and the office with the advent of urgent care walk-in clinics and facilitated same-day appointments, and primary care providers may find themselves dealing with patients who present with a new, acute severe headache. These patients typically require emergent CT scanning to evaluate for subarachnoid hemorrhage, followed by immediate neurosurgical referral if the CT scan is positive for subarachnoid hemorrhage and likely lumbar puncture if the CT scan is negative for subarachnoid hemorrhage and shows no mass effect. Because of the long list of danger signs, it is actually easier to remember who doesn't need to be imaged than who does need to be imaged.

Headache – who not to image

As noted in the previous section, patients with typical clinical features of primary headache from tension type headache or migraine headache do not usually require imaging, whereas patients meeting criteria for cluster headache do require imaging. Patients with no substantial change in their usual headache pattern, with no new concerning features (seizure, trauma, fever), and with no focal neurologic symptoms or abnormal neurologic exam findings do not require imaging, urgent or otherwise[8]. Conversely, patients with a change in their typical headache pattern *do* require imaging (Figure 1).

Headache – danger signs

A long list of headache features should provoke concern on the part of the clinician. Chief among these features is that the headache is the "worst or first"[5] and severe headaches with rapid onset, so-

called "thunderclap" headaches[9]. These features should provoke immediate transport to the emergency room or CT scanner. Other features accompanying the headache which should cause concern include a change in mental status or fluctuation in the level of consciousness (Figure 2), focal neurological symptoms (Figure 3), fever (Figure 4), rapid onset of pain during strenuous exercise, and headache spreading to the lower neck and between the shoulders[5]. Furthermore, new headache in a patient with cancer suggests metastasis (Figure 5), while headache during pregnancy or the post-partum period may signal any of several puerperal complications including cortical vein thrombosis, carotid dissection, and pituitary apoplexy[10]. Headache and neck pain following a round of golf or a visit to the chiropractor should arouse suspicion for carotid artery dissection.

Figure 2. Hemorrhagic cerebellar infarction in a 61 year old woman with headache and altered mental status. The patient initially had headache, dizziness, and slurred speech, then became unresponsive. She did not survive. Axial unenhanced CT shows massive cerebellar hemorrhage (arrow).

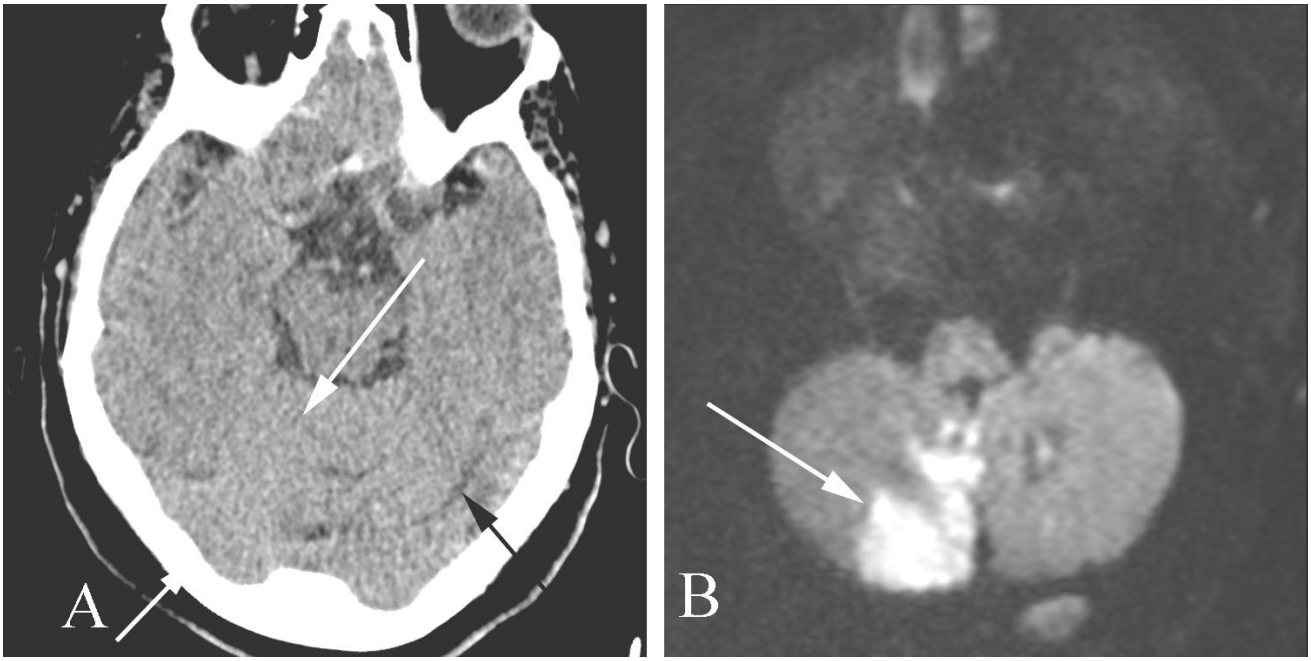

Figure 3. Nonhemorrhagic cerebellar infarction in a 65 year old man with headache who also had neurologic symptoms (dizziness and slurred speech). A. Axial unenhanced CT scan through the posterior fossa shows a broad area of effaced sulci indicating brain swelling (white arrows). Note the normal contralateral cerebellar hemisphere sulcus (black arrow). B. Diffusion weighted magnetic resonance imaging study shows restricted diffusion of the right cerebellar hemisphere, typical for stroke (arrow).

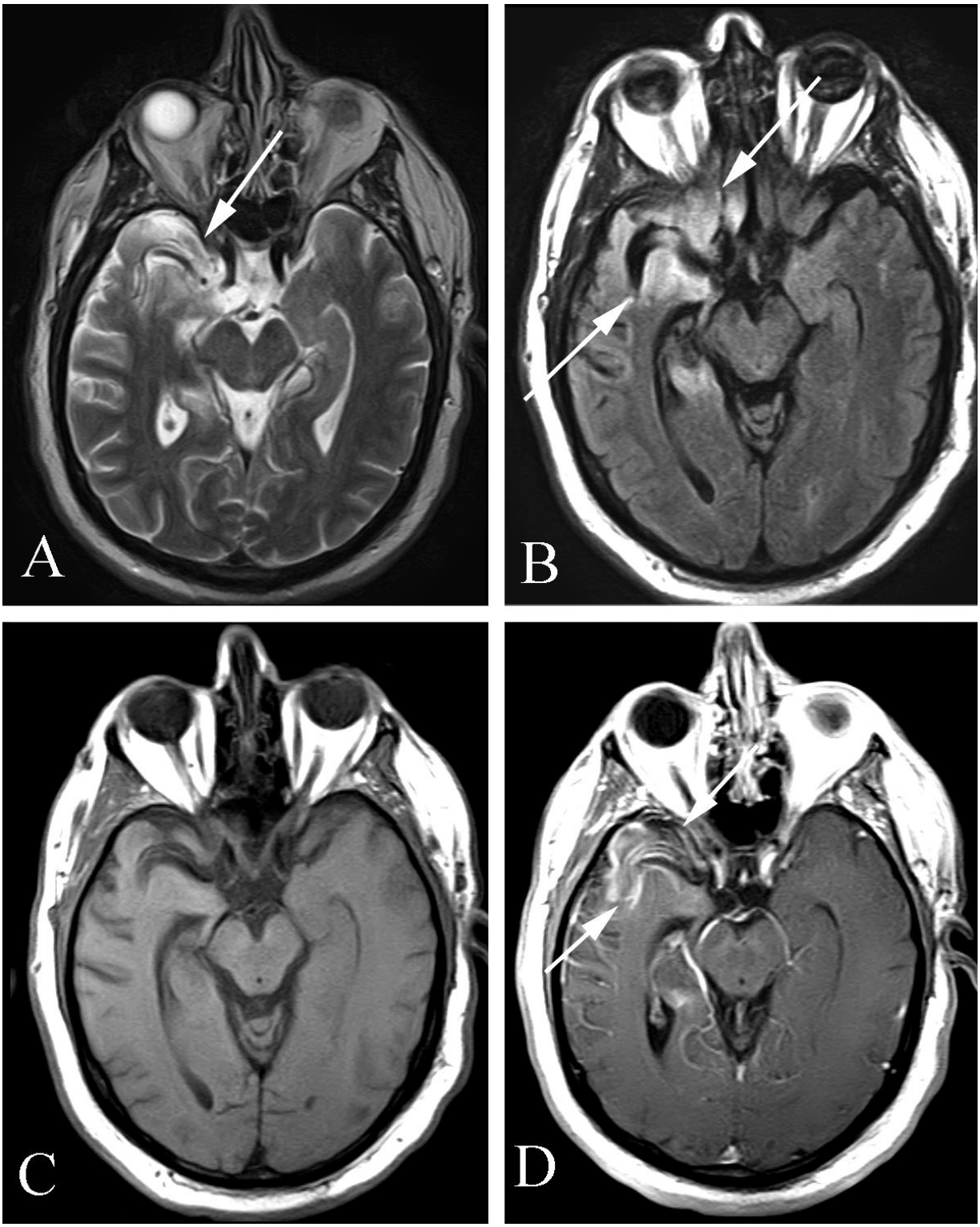

Figure 4. Herpes encephalitis in a 59 year old man with headache who also had fever. A. Axial T2 weighted MR image shows increased signal through the right temporal lobe (arrow). B. Axial FLAIR MR imaging also shows increased signal through the temporal lobe (arrows). C. Axial T1 weighted enhanced MR image shows accentuated sulci in the right temporal lobe. D. Axial T1 weighted postcontrast MR image demonstrates intense contrast enhancement of the abnormal brain parenchyma (arrows).

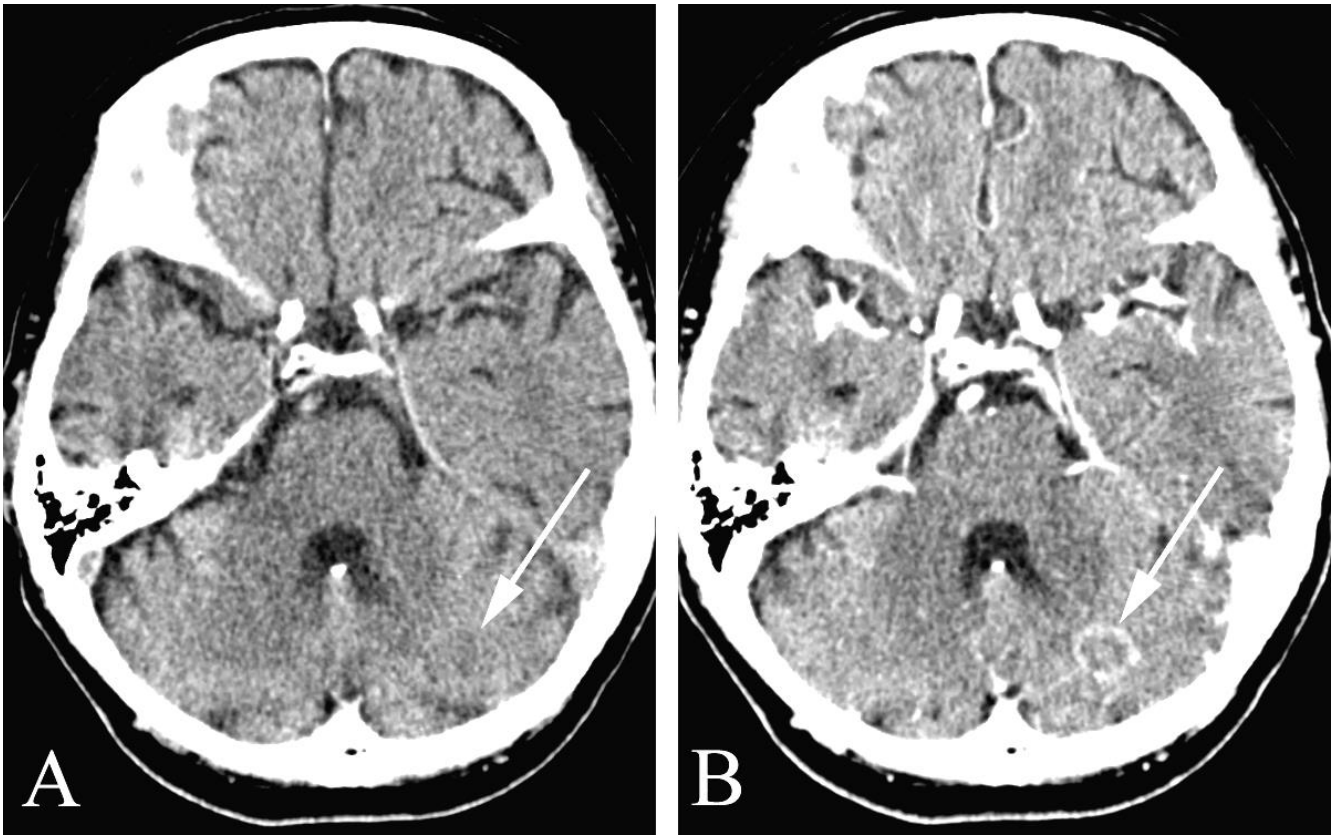

Figure 5. Metastatic disease in a 74 year old man with headache who had known lung cancer. A. Axial unenhanced CT study shows a subtle area of hypodensity in the left cerebellar fossa (arrow). B. Axial contrast enhanced CT shows a "rim enhancing lesion" (also called a "ring enhancing lesion") with peripheral contrast enhancement around a centrally isodense lesion compatible with metastatic disease (arrow). Note that such rim enhancing lesions may also be seen in primary brain tumors and abscesses.

Headache caused by subarachnoid hemorrhage

About 20% of patients who state that they are having "the worst headache of my life" will have a subarachnoid hemorrhage[11]. When a head CT demonstrates acute subarachnoid hemorrhage (Figure 6), the cause must be established as rapidly as possible because without treatment the likelihood of death in the next 30 days is greater than 50%[11]. This may be accomplished by immediate computed tomographic angiography (CTA) of the cerebral vascular tree, often the preferred method of imaging in perilously ill patients who require emergency craniotomy for evacuation of a large subarachnoid clot[11]. CTA performed on modern helical CT scanners is at least 90% accurate at identification of ruptured aneurysms[12]. On the other hand, if the patient is stable enough to undergo catheter angiography, this technique not only offers the gold standard in diagnosis, but also allows life saving percutaneous therapeutic treatment of leaking aneurysms (Figure 6). The decision of which specialist to use (neurosurgeon versus interventional neuroradiologist) and which technique is then employed for treatment (open repair versus percutaneous intervention) varies with local expertise.

When the CT demonstrates subarachnoid hemorrhage but CTA and subsequent catheter angiography fails to demonstrate a leaking aneurysm or other cause (e.g., vascular malformation, intracranial arterial dissection, or vasculitis), then MR (done without and with contrast) should be performed to search for alternative explanations of subarachnoid hemorrhage (e.g. angiographically occult vascular malformation, bleeding pituitary adenoma)[13]. If the CTA (when done), catheter angiography, and MRI

are all negative in a patient with a proven subarachnoid hemorrhage, angiography is repeated two weeks later since an aneurysm may be seen only on the delayed study[11].

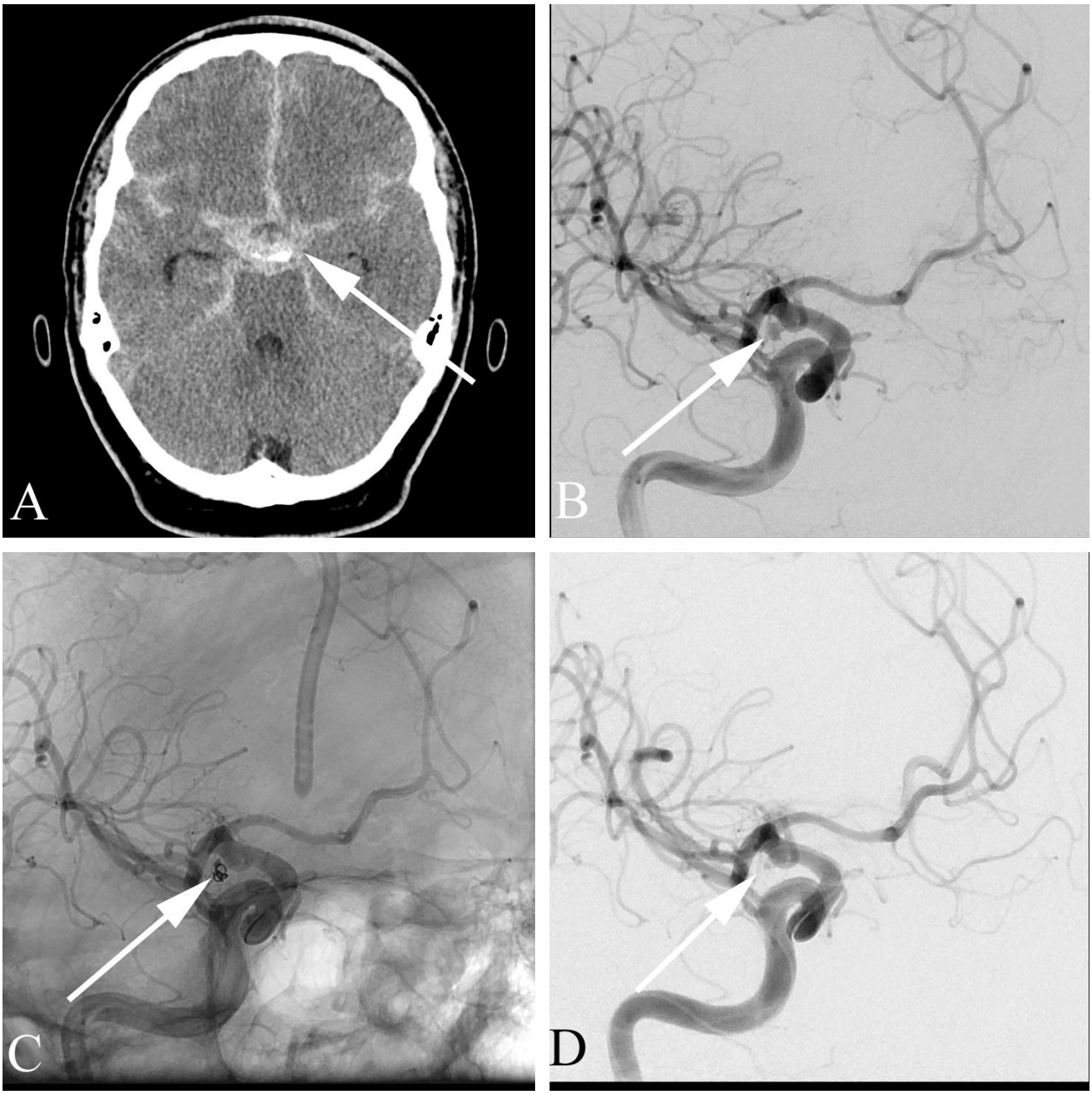

Figure 6. Subarachnoid hemorrhage from a bleeding aneurysm in a 60 year old man with thunderclap headache, nausea, and vomiting. A. Axial unenhanced CT study shows extensive subarachnoid hemorrhage in the suprasellar cistern (arrow) with extension between the hemispheres, around the brainstem, and along the sulci of the temporal lobes. B. Oblique image from catheter angiography demonstrates an aneurysm off of the distal internal carotid artery. C. Oblique image (nonsubtracted) from catheter angiography following coil deployment shows the coil at the former location of the aneurysm. D. Oblique image (digitally subtracted) from catheter angiography following coil placement demonstrates minimal flow into the aneurysm following successful coil placement (compare with "B").

Patients with a negative head CT suspected to have a subarachnoid hemorrhage on the basis of the clinical presentation (e.g. a thunderclap headache) need to undergo a lumbar puncture, because the lumbar puncture is more sensitive for the detection of small amounts of subarachnoid hemorrhage[11]. It is critical to identify these patients, because up to half of patients with major SAH will have a minor SAH or "warning leak" 6 to 20 days before the major leak[14], and identification of the aneurysm will allow treatment prior to the possible lethal rupture of the aneurysm.

Headache caused by intraparenchymal intracranial hemorrhage

CT in headache patients may demonstrate an intraparenchymal hematoma[15]. These hematomas may accompany a large variety of diseases including primary and metastatic brain tumors (Figure 7), hypertension with presumed vascular rupture (Figure 8), sympathomimetic drug abuse (e.g., methamphetamines or cocaine), as a complication of AIDS, amyloid angiopathy, bleeding diasthesis/anticoagulation (Figure 9) and parenchymal vascular malformations (Figure 10)[16]. These lesions will typically be referred to interventional neuroradiologists, neurosurgeons and neurologists. These specialists will order (in addition to the initial unenhanced CT study showing the intraparenchymal hemorrhage), further imaging studies, such as contrast-enhanced CTA, MRI done without and with contrast, and/or an angiography in order to establish the diagnosis (Figure 10).

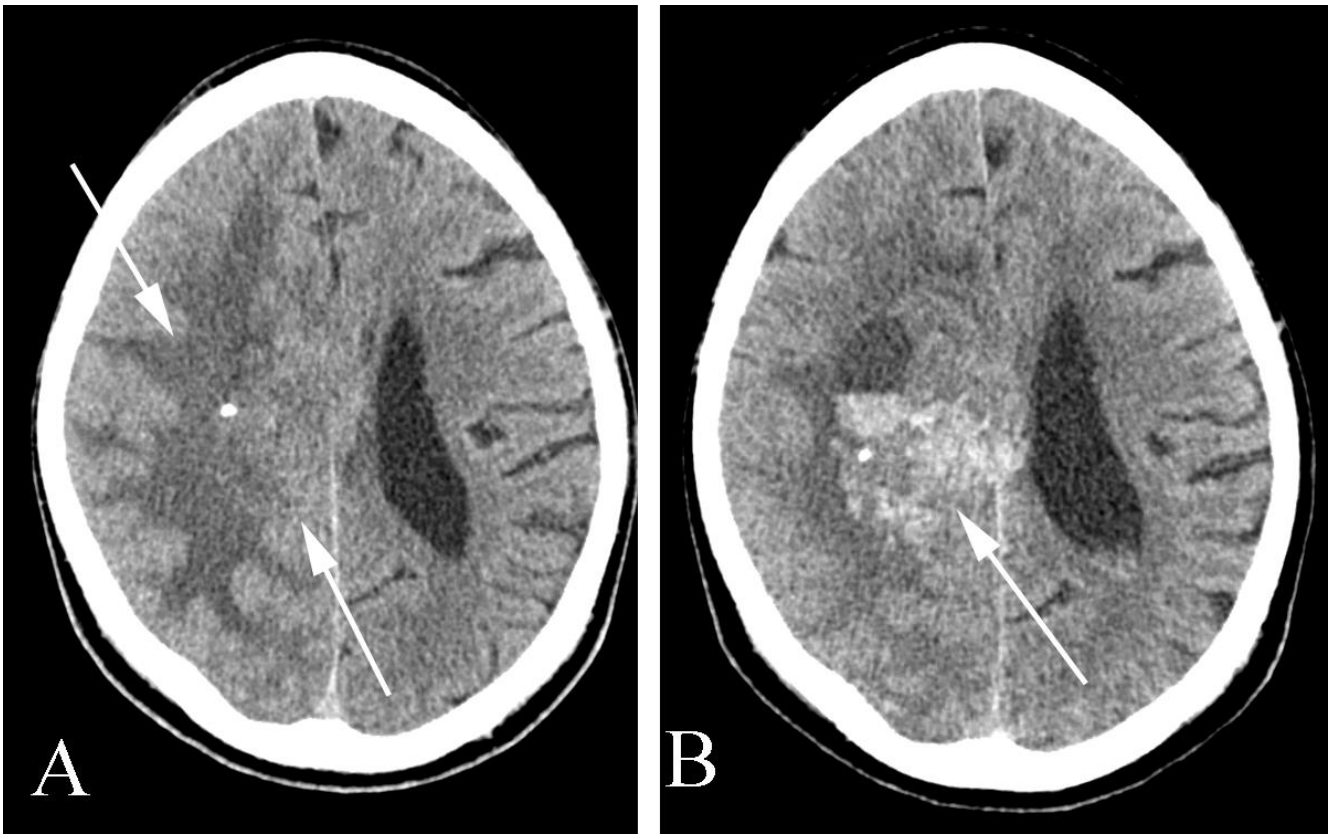

Figure 7. Intraparenchymal hemorrhage in a 40 year old man with a headache and a known right hemisphere oligodendroglioma. A. Axial unenhanced CT done prior to the headache as part of tumor monitoring shows a mass effacing the right lateral ventricle (arrows). B. Axial unenhanced CT done after the onset of a new headache demonstrates hemorrhage into the tumor (arrow).

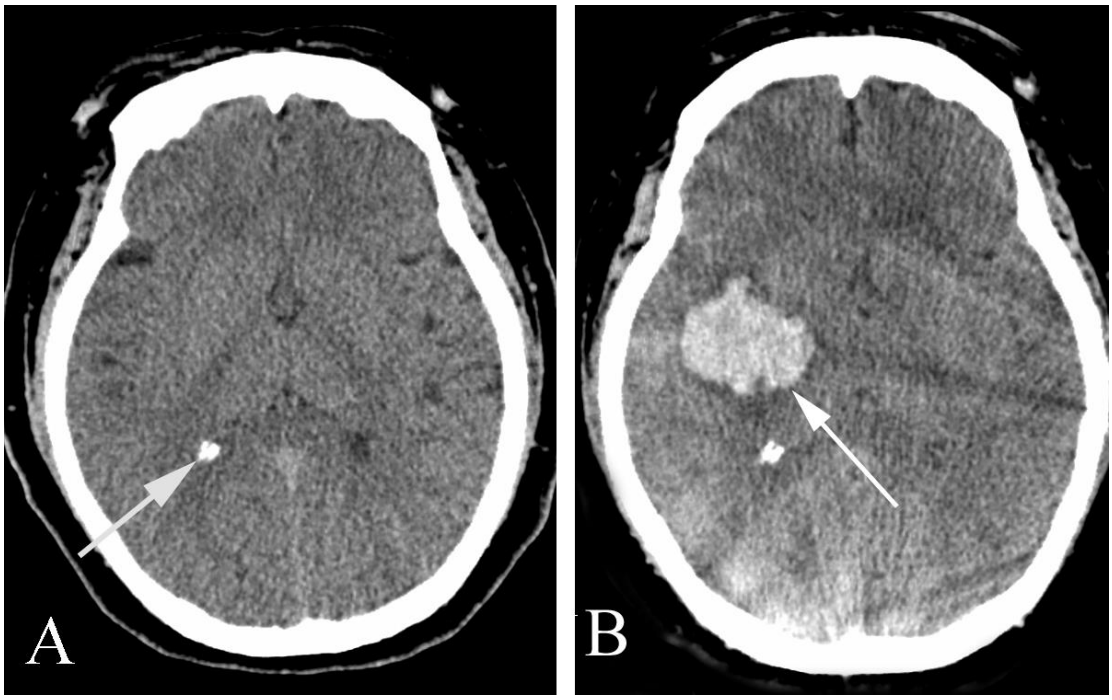

Figure 8. Intraparenchymal hematoma in a 51 year old with headache and slurred speech along with left-sided weakness. A. Axial unenhanced CT study done six months previous to the development of headache and neurologic symptoms demonstrates normal brain parenchyma. Incidentally noted are (normal) calcifications of the choroid plexus in the right occipital horn of the lateral ventricle (arrow). B. Axial unenhanced CT done at the time of the headache and neurologic symptoms demonstrates an acute hemorrhage into the right basal ganglia (arrow).

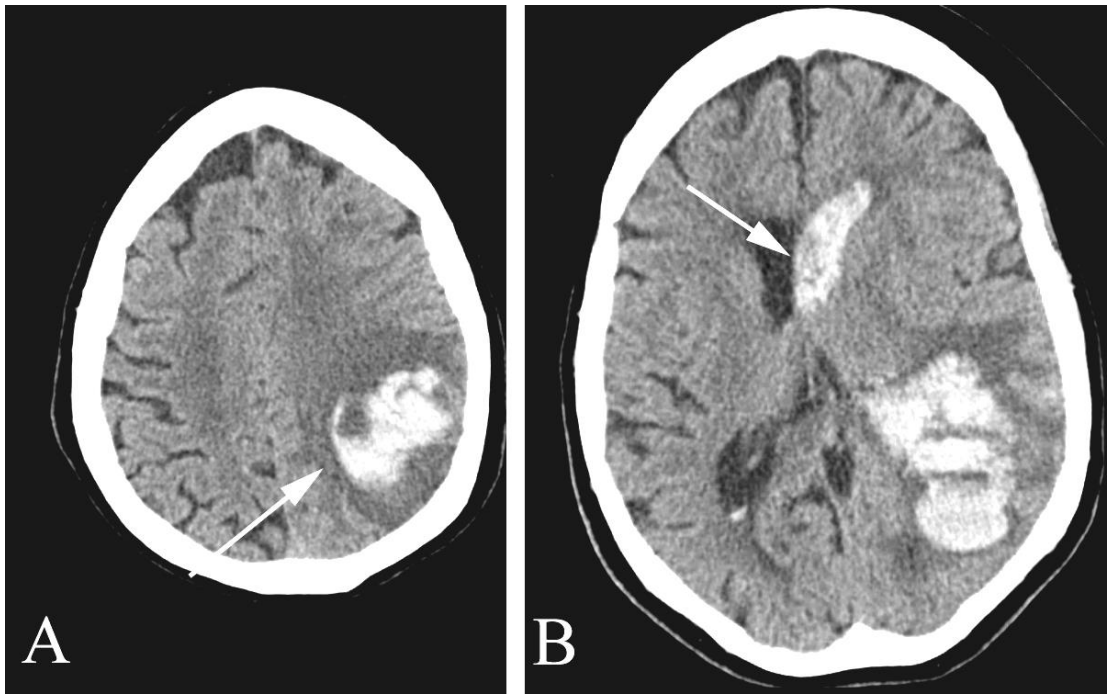

Figure 9. Intraparenchymal and intraventricular hematoma in an anticoagulated 79 year old with headache and acute mental status changes. A. Axial unenhanced CT shows extensive hemorrhage into the posterior left frontal lobe (arrow). B. Axial unenhanced CT demonstrates hemorrhage extending into the parietal lobe and into the lateral ventricle (arrow).

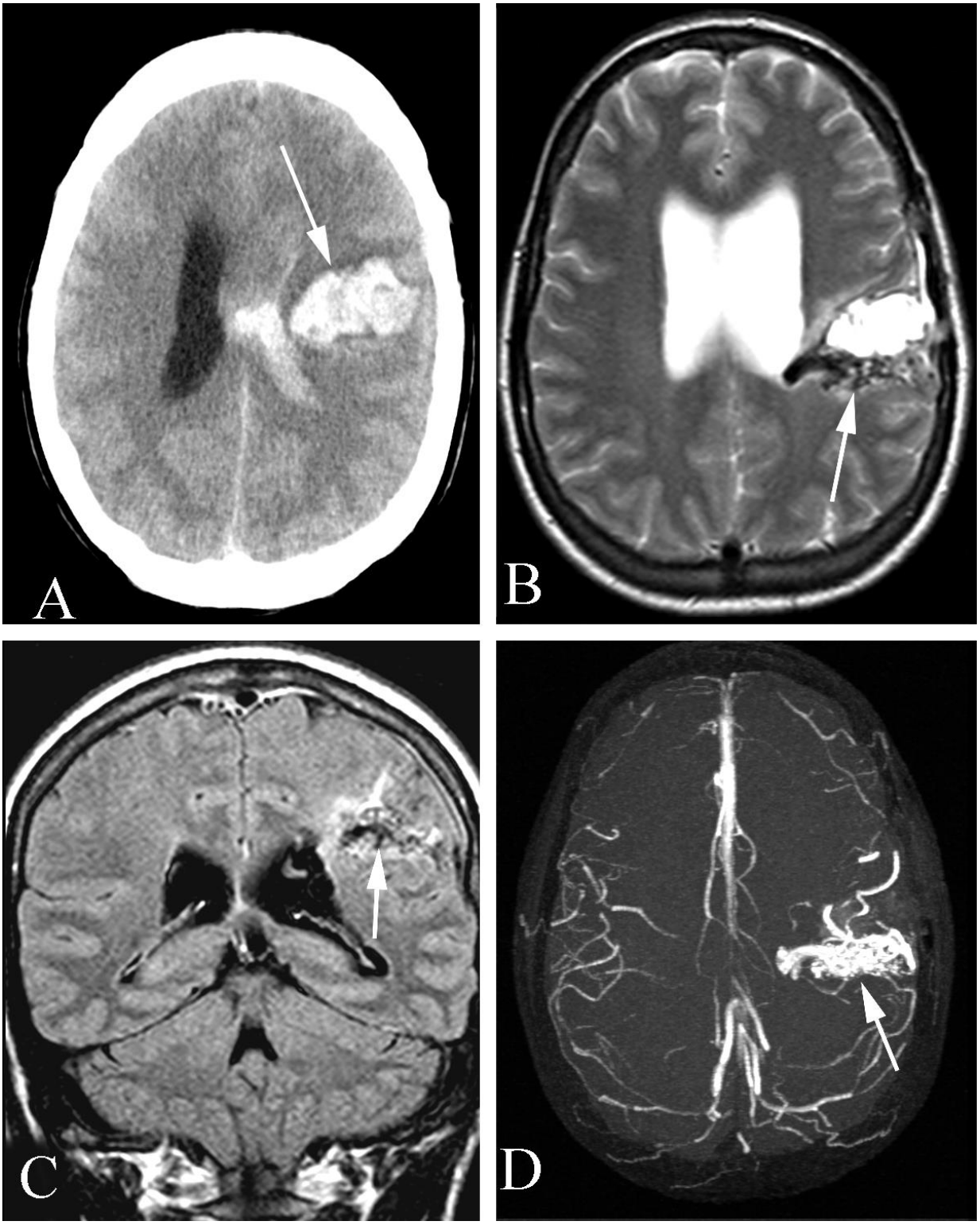

Figure 10. Intraparenchymal and intraventricular hematoma secondary to an intracranial arteriovenous malformation in a 45 year old woman with headache and new onset of left facial droop. A. Axial unenhanced CT demonstrates a left frontal lobe hematoma (arrow) as well as intraventricular hemorrhage. B. An axial T2 weighted MR study demonstrates the hematoma with abnormal vessels along the posterior margin (arrow). C. Coronal T1 weighted postcontrast MR study shows a complex “salt-and-pepper” appearance of the lesion. D. Axial MR angiogram demonstrates multiple abnormal vessels (arrow).

Headache caused by subdural hematoma

CT in headache patients may also demonstrate a subdural hematoma, seen more frequently in the elderly, particularly when anticoagulated or following trauma (Figure 11). The CT features are highly characteristic and diagnostic, and the clinical issue in these patients is whether it is worthwhile to surgically drain the hematoma (typically done through a burr-hole drilled in the calvarium) or to allow the body to resorb the hematoma without intervention.

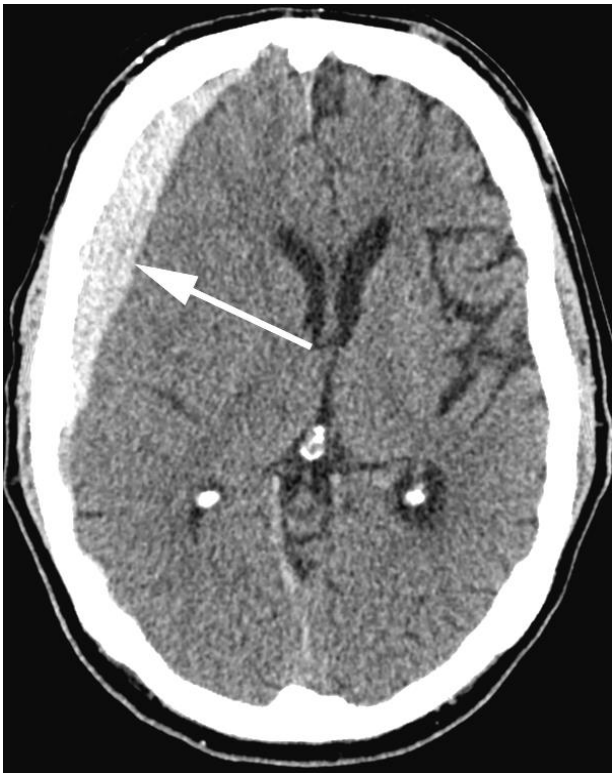

Figure 11. Subdural hematoma in a 66 year old man with headache and slurred speech along with decreased left-sided strength. Unenhanced axial CT study shows an acute subdural hematoma (arrow) compressing the right frontal lobe, and shifting the midline structures.

SECONDARY HEADACHES MAY RARELY BE INSIDIOUS AND MIMIC PRIMARY HEADACHES

While most patients with subarachnoid hemorrhage will present with a thunderclap headache or a similar dramatic event, and most patients with subdural hematomas, brain tumors, and strokes will have some feature in their history or on their physical examination to alert the clinician that they have something other than a primary headache, there are exceptions to this rule (Figure 12). As noted in the first section of this chapter, it is reasonable to not image patients with typical features of primary headache (except for cluster headache). As noted in the second section of this chapter, it is also reasonable to not image those patients with headache with no new or concerning features. Having said this, however, one should also note that headache is a common manifestation of, for example, brain tumor, and that one study of 111 patients with brain tumors found headache in about half. Tension type headache accounted for 77%, migraine type 9%, and other headache types 14% of headaches accompanying brain tumors[17]. Of course, as brain tumors grow, they will eventually produce neurological symptoms. Because of the possibility of a presumed primary headache actually representing a secondary headache, with the headache being secondary to a treatable cause, the decision as to which headache patients to image must ultimately rest with the clinician and the patient, and obtaining an imaging study may be a reasonable course of action for a patient where there is a significant suspicion of a causative lesion. When imaging is done in these cases, the preferred method is magnetic resonance imaging, done without and with contrast material. MR involves no ionizing radiation and is considerably more sensitive than CT to some causes of headache, which is relatively insensitive to certain parenchymal tumors (Figure 12).

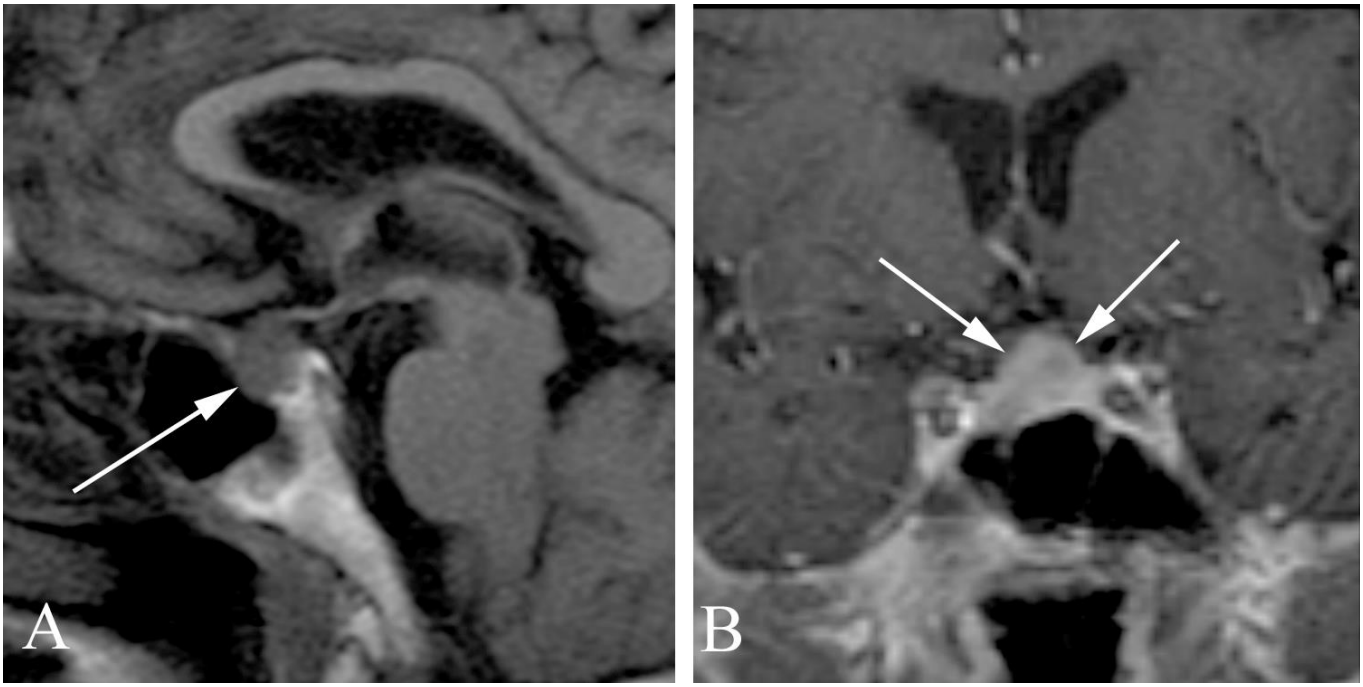

Figure 12. Pituitary adenoma in a 79 year old woman with headache, nausea, and vomiting. A. Sagittal unenhanced T1 weighted MR study shows a 10 mm pituitary adenoma (arrow). B. Coronal T1 weighted postcontrast MR study shows intense enhancement of the pituitary adenoma (arrows).

SUMMARY

Primary care providers see many patients with headaches, and most of these patients do not require imaging, particularly if they have straightforward features of tension or migraine type headaches. Cluster headaches should be evaluated with MR. Patients with headaches secondary to intracranial hemorrhage, tumors, or other processes may demonstrate "danger" signs, the most conspicuous of which is a "thunderclap" headache described as the first or worst headache of the patient's life. Such headaches should undergo immediate imaging, typically with CT, followed by lumbar puncture if the CT shows no hemorrhage or mass effect.

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