"Doc, I've got this headache": Imaging a common malady.

Whether you practice pediatrics or geriatrics, headache is a frequently heard complaint. Headache prevalence has been reported as high as 71% in adults and 48% in children. North America and Europe have a higher incidence than South America and Asia.

When is headache a simple malady of life, and when is it the harbinger of serious disease? When should you image the headache patient? With CT or MR? With contrast or without? No one wants to “miss” the brain tumor causing an innocuous sounding headache, but how often does that happen? This article will address some of the more common scenarios encountered in the outpatient setting.

The American College of Radiology (ACR) and the American College of Emergency Physicians (ACEP) recently updated their guidelines on imaging of headache. Links are available on the Raleigh Radiology website www.raleighrad.com. The guidelines address when to order, what to order, and provide reassurance when imaging is unlikely to be of benefit. They are formatted by clinical scenario for ease of reference, and based upon thorough statistical review of the evidence-based literature.

Imaging of headache, not surprisingly, has a low yield. Some populations have significantly higher rates. The classic “thunderclap” headache of subarachnoid hemorrhage (SAH) has a reported yield of 47%. Similarly, the sudden onset of severe unilateral headache with neck pain and a Horner syndrome is predictive of arterial dissection, with 68% of patients reporting headache. On the other hand, the yearly incidence of primary malignant brain tumors in the US is only 7 in 100,000. Headache was a symptom equally of metastatic or primary tumor in 47% of patients in one study, but only 8% presented with headache as an isolated symptom. In one study of children with isolated headache, sleep-related pain and absent migraine family history were the strongest predictors of tumor.

The highest predictive factors of positive findings are focal neurological signs; HIV+ or other immunocompromised state; cancer; seizures; meningeal irritation; and pregnancy. In the absence of these factors, the yield will be low, but imaging may sometimes be warranted for the reassurance factor or medical-legal concerns. Patient expectations and/or medical legal considerations accounted for 17% of the reasons for ordering neuroimaging studies in one Canadian study. It may be reasonable to assume it is higher in the U.S. According to Jordan, “…the costs of imaging headache are always overstated when the value of negative results is not considered”.

CT has been utilized most because of widespread availability, rapid image acquisition, and lower cost than MRI. Concerns of over-utilization and radiation exposure, especially in the pediatric population, are being raised in the medical and lay communities. All Raleigh Radiology physicians and Technologists have taken the "Image Wisely" pledge. Our CT protocols adhere to the "Image Gently" campaign to reduce pediatric dosing. This is common sense, and follows the time honored “ALARA” dictum on radiation exposure learned by every first year Radiology resident: "As Low As Reasonably Achievable”.

Radiation exposure was clearly addressed by Raleigh Radiology physicians in a recent RaleighRad Note, also available on our website. It contains useful tables for comparing radiation dosing and risks and is helpful in addressing concerns from patients. In the US now, the majority of diagnostic imaging is performed by non-radiologists. Radiologists are trained extensively in radiation physics and safety during their five to six year post-graduate training programs. All practitioners administering ionizing radiation should be cognizant of ALARA, and dedicated to the cause of public radiation safety.

As a general statement, CT is preferred in urgent situations (e.g., “thunderclap headache; closed head injury) while MRI is preferable in non-urgent scenarios. CT remains necessary in patients who have contraindications for MRI such as a pacemaker. (MRI compatible pacemakers are being introduced.) CT angiography or venography can be obtained at the same time as a diagnostic CT. Increasingly, aneurysm treatment may proceed on the basis of CTA or MRA without conventional angiography. Both can detect aneurysms as small as 3 mm, below which the risk of rupture is small.

CTA and MRA are useful for arterial dissection, AVM and other vascular abnormalities associated with headaches such as vasculitis, although the latter may still require conventional angiography. Patients over the age of 60 with new onset temporal headache and ESR >55 are a high-risk population for vasculitis. CT venography (CTV) is highly sensitive for venous sinus thrombosis, seen more often in hypercoagulable and dehydration states.

MRI is more sensitive than CT for a wider range of pathology. The role of gadolinium has been reduced because of the development of sequences beyond traditional spin-echo T1 and T2. These have resulted in significantly increased sensitivity for stroke, hemorrhage, edema, and white matter abnormalities without contrast. All Raleigh Radiology routine brain MRI studies include these special sequences of diffusion weighted imaging (DWI), able to detect ischemia immediately; FLAIR for white matter lesions, edema, and subarachnoid blood; and GRE T2*, exquisitely sensitive for even petechial or remote parenchymal blood. Gadolinium is indicated for tumor, infection, and other pathologies associated with breakdown of the blood-brain barrier.

We encourage "contrast as needed” ordering, unless sure of the protocol desired, for CT and MRI because it allows use of established protocols tailored for the indication given without having to contact the ordering provider to change an order. We often review images while the patient is still on the scanner for “contrast as needed” exams. If the non-contrast study is normal, the exam is often concluded, reducing cost, scan time, IV discomfort, and gadolinium exposure. HIV+ patients, those with known or suspected neoplasm, and other high-risk patients should be imaged with gadolinium (MR +), except in pregnancy. The pregnant patient with headache is at risk for serious intracranial pathology such as venous sinus thrombosis and stroke secondary to hypercoagulability, hypertension, and other risk factors associated with pregnancy. MRI (-) is sensitive to most of these complications. MR venography is performed without contrast, an advantage over CTV in this population. Intracranial MRA is also performed without contrast, whereas extracranial MRA and CTA are performed with it.

In the patient with mild traumatic brain injury (TBI), the ACEP guidelines answer the question of which patients should have a non-contrast head CT: Head trauma patients with loss of consciousness (LOC) or posttraumatic amnesia only if one or more of the following is present: headache, vomiting, age greater than 60 yrs, drug or alcohol intoxication, deficits in short-term memory,
physical evidence of trauma above the clavicle, posttraumatic seizure, GCS less than 15, focal neurological deficit or coagulopathy.”

In patients with no LOC or posttraumatic amnesia, recommendations for non contrast CT are: “focal neurological deficit, vomiting, severe headache, age 65 years or greater, physical signs of a basilar skull fracture, GCS score less than 15, coagulopathy, or a dangerous mechanism of injury.”

Raleigh Radiology is committed to being an available partner in appropriate, cost effective, and expertly interpreted imaging in all subspecialty fields. We have a fellowship-trained neuroradiologist every weekday at Rex Hospital for consultation. (There is a board-certified Radiologist in-house 24/7.) Raleigh Radiology has eight outpatient sites in the Triangle, from Brier Creek to Clayton, and Wake Forest to Cary, offering 16-slice multidetector CT scanners and 1.5T MRI magnets. Our Blue Ridge and Cedarhurst facilities have 1.5T Open Bore MRI scanners for your obese and claustrophobic patients as well as offer IV Valium sedation. Images are immediately available for your viewing on our PACs system, with rapid-report turn-around, and STAT reads by phone or fax if requested.

Staying abreast of the latest techniques, protocols, and indications in diagnostic imaging is challenging even for physicians devoting our careers to the field. We want to make it as easy as possible for referrers to choose the best examination. We appreciate the trust and confidence placed in us, and strive to meet the expectations and needs of our colleagues who are on the frontlines of patient care.

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>CT, head, without contrast</th>
<th>CT, head, with contrast</th>
<th>MR imaging, brain, without and with contrast</th>
<th>MR imaging, brain, without contract</th>
<th>MR angiography, head, with or without contrast</th>
<th>CT angiogram, head</th>
<th>Angiography, cerebral</th>
<th>MR angiography, head and neck, with or without contrast</th>
<th>CT angiogram, head and neck</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worsened chronic headache. History of headache.</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Sudden onset of severe headache (&quot;Worst headache of one's life, thunderclap headache&quot;).</td>
<td>9</td>
<td>6</td>
<td>6a</td>
<td>7a</td>
<td>8</td>
<td>8</td>
<td>7</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Sudden onset of unilateral headache, or suspected carotid or vertebral dissection or ipsilateral Horner syndrome.</td>
<td>8</td>
<td>6</td>
<td>8b</td>
<td>8b</td>
<td>X</td>
<td>X</td>
<td>7</td>
<td>8c</td>
<td>8c</td>
</tr>
<tr>
<td>Headache, suspected complication of sinusitis and/or mastoiditis.</td>
<td>7d</td>
<td>6d</td>
<td>8</td>
<td>7</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>New headache in patient older than age 60. Sedimentation rate higher than 55, temporal tenderness. Suspected temporal arteritis.</td>
<td>6</td>
<td>5</td>
<td>7c</td>
<td>8c</td>
<td>X</td>
<td>X</td>
<td>4e</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>New headache in HIV+ individual.</td>
<td>6f</td>
<td>5</td>
<td>8</td>
<td>8</td>
<td>3g</td>
<td>3g</td>
<td>2e</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>New headache in pregnant patient.</td>
<td>8</td>
<td>X</td>
<td>5h</td>
<td>8</td>
<td>5i</td>
<td>2j</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>New headache. Suspected meningitis/encephalitis.</td>
<td>8k</td>
<td>6l</td>
<td>8</td>
<td>6m</td>
<td>6i</td>
<td>3n</td>
<td>X</td>
<td>X</td>
<td>X</td>
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</tbody>
</table>

Note:—Appropriateness criteria scale from 1 to 9, 1–least appropriate, 9–most appropriate;
a, may be helpful after CT depending on CT findings;
b, with diffusion-weighted sequences;
c, usage of CT versus MR imaging depends on local preference and availability;
d, include sinuses;
e, if noninvasive imaging unrewarding;
f, if MR imaging not available;
g, if vascular lesion suspected;
h, pregnancy is a relative contraindication to gadolinium administration, reserve for urgent medical emergency;
i, MR venography (MRV) should also be performed;
j, if MR imaging not available, contraindicated or inconclusive;
k, to exclude intracranial pressure changes;
l, MR imaging preferable, depending on availability;
m, needs contrast;
n, useful for problem solving or if there is a strong suspicion of vascular disease;
o, US, neck (carotid duplex) rating of 3;
p, x-ray skull rating of 4;
q, CT, head, with contrast rating of 3.

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\]
References and Links:

1. Moran and Browne RaleighRad Note. This issue also contains useful links for information, radiation risks, etc.

2. [http://www.ajnr.org/cgi/content-nw/full/28/9/1824/T1](http://www.ajnr.org/cgi/content-nw/full/28/9/1824/T1)

Table Appropriateness Criteria Chart Clinical Condition Headache

3. [http://www.ajnr.org/cgi/content/full/28/9/1824#T1](http://www.ajnr.org/cgi/content/full/28/9/1824#T1)


4. ACR Appropriateness Criteria search page for headache in adults and children and head trauma:


5. ACEP Clinical Policies


   **Clinical Policy: Neuroimaging and Decision-making in Adult Mild Traumatic Brain Injury in the Acute Setting**

   **Clinical Policy: Critical Issues in the Evaluation and Management of Adult Patients Presenting to the Emergency Department with Acute Headache**

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