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CT Angiography for Subarachnoid Hemorrhage

Opposing authors provide succinct, authoritative discussions of controversial issues in emergency medicine. Authors are provided the opportunity to review and comment on opposing presentations. Each topic is accompanied by an Editor's Note that summarizes important concepts. Participation as at authoritative discussant is by invitation only, but suggestions for topics and potential authors can be submitted to the section editors.

Editor's Note: *Physicians often encounter resistance in performing lumbar puncture on patients presenting with suspected subarachnoid hemorrhage and normal noncontrast head computed tomography (CT). Despite an absence of supporting literature, an increasing number of clinicians are advocating using CT angiography, with its ability to identify vascular sources of subarachnoid hemorrhage, as the initial study in suspected subarachnoid hemorrhage, thereby eliminating the need for lumbar puncture in most patients. Although this approach is likely to decrease the need for lumbar puncture, it carries its own set of complications and challenges. In this installment of Clinical Controversies, pro and con advocates discuss opposing perspectives and present the available evidence and arguments that must be considered in deciding whether to adhere to the conventional CT–lumbar puncture diagnostic strategy or embrace CT angiography as an alternative strategy in evaluating patients with suspected subarachnoid hemorrhage.*

COMPUTED TOMOGRAPHY ANGIOGRAPHY OF THE HEAD IS A REASONABLE NEXT TEST AFTER A NEGATIVE NONCONTRAST HEAD COMPUTED TOMOGRAPHY RESULT IN THE EMERGENCY DEPARTMENT EVALUATION OF SUBARACHNOID HEMORRHAGE

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Although subarachnoid hemorrhage is rare, identifying a sentinel bleeding event is one of the most beneficial things an emergency physician can accomplish. For this discussion, we assume that a negative noncontrast computed tomography (CT) scan of the head is inadequate to rule out a sentinel subarachnoid hemorrhage and must be followed by another test; traditionally, a lumbar puncture. We argue that after a nondiagnostic CT result, CT angiography is an acceptable alternative in patients with a reasonable previous probability of subarachnoid hemorrhage.

Although the sensitivity of lumbar puncture for subarachnoid hemorrhage approaches 100%, it has other suboptimal characteristics. It is invasive and painful, and it often causes considerable patient anxiety such that some patients will leave against medical advice if given no other choice. Not infrequently, lumbar puncture causes a significant postdural puncture headache, the incidence of which is estimated to range from 10% to 40%.[1] This complication can require medical therapy, epidural blood patch, and even admission. (The literature is unfortunately not helpful about the frequency of any of these.) Lumbar puncture results are often inconclusive, mostly because of traumatic taps (in 15% to 20% of patients); and arbitrary cutoffs for RBC count, change in counts between tubes, or evaluation of xanthochromia cannot resolve this problem.[2] Last, lumbar puncture can be technically difficult, depending on patient body habitus, and is time consuming for the emergency physician, which can interfere with the care of other acutely ill patients.

Substituting CT angiography for lumbar puncture has several advantages. It is painless and noninvasive, and can be performed rapidly; from the emergency physician standpoint, it requires little time. Diagnostically, it can identify other important causes of worrisome headache (eg, venous sinus thrombosis, ischemic stroke, arteriovenous malformation), even if subarachnoid hemorrhage is not present, albeit while forgoing cerebrospinal fluid analysis.[3] A recently published mathematical probability model suggests that this strategy would have a sensitivity of 99.5% for aneurysmal subarachnoid hemorrhage and is eminently reasonable for most such patients.[4]

There are important disadvantages of CT angiography. First, the reported prevalence of incidental cerebral aneurysms in the general population is between 0.5% and 6%, depending on study design, and is likely to be at least 2%.[5] The majority of these will never cause a clinical problem. Thus, approximately 1 in 50 patients being evaluated for possible subarachnoid hemorrhage, in whom subarachnoid hemorrhage is *not* present, will have an incidental aneurysm identified. It is not currently possible to distinguish these from a truly dangerous aneurysm that is causing the index headache,

which could lead to harm from unnecessary neurosurgical intervention. Fortunately, this problem can be mitigated by simply by following any CT angiography that shows an aneurysm, but no visible bleeding (2% to 5% of cases), with a lumbar puncture. Such an approach would greatly diminish the number of lumbar punctures done, but still identify patients with a false-negative CT and those with a false-positive CT angiography (ie, aneurysm but no subarachnoid hemorrhage).

While this would prevent unnecessary surgery based solely on the presence of a bystander aneurysm, it would not address the psychological harm associated with telling a patient that he or she has what many will think of as a "ticking time bomb in your brain" – even though we know that most of these are innocuous, and ideally left undiscovered.

The second major concern with CT angiography is increased radiation exposure. The effective radiation dose of this test is approximately 2 mSv for adults.[6] To put this into context, this represents less than one third the radiation received during a CT scan of the abdomen (8 mSv) and even less than natural annual background radiation (3 mSv) in the United States.[7] Directly and precisely estimating increased cancer risk from acute exposures of less than 10 mSv is difficult to achieve but is certainly not zero.[7] Nonetheless, extrapolation from epidemiologic data suggests that the lifetime attributable risk of death from cancer associated with a single CT head scan is less than 0.01% for individuals older than 25 years.[8] Although obviously important, this risk is small, with a number needed to harm of 10,000, and even less in older adults, who compose the majority of those evaluated for subarachnoid hemorrhage.

Third, CT angiography exposes the patient to the risk of acute allergic reaction and contrast-induced nephropathy. However, the risk of severe allergic reaction is extremely low, ranging from 0.001% to 0.02%, and has decreased since the advent of nonionic, low-osmolality contrast formulations.[9] Recent reports estimating the incidence of contrast-induced nephropathy from CT angiography of the head suggest that the risk of clinically significant, patient-oriented adverse outcomes is negligible.[10]

In sum, we do not argue that CT angiography is superior to lumbar puncture as a next test after a negative noncontrast CT head scan result, but rather that it is an acceptable alternative diagnostic strategy in adults who are at risk for subarachnoid hemorrhage. We do not mean to suggest that routinely adopting an approach involving CT angiography is better than adopting one involving lumbar puncture, but neither would we argue the opposite. Rather, we propose that a third approach, centered on shared decisionmaking, is the one that should be adopted: after informing our patients about each of these perfectly reasonable approaches, we help them choose according to their own values and preferences.

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REFERENCES

1. Evans RW. Complications of lumbar puncture. *Neurol Clin*. 1998; 16:83-105.
2. Shah KH, Richard KM, Nicholas S, et al. Incidence of traumatic lumbar puncture. *Acad Emerg Med*. 2003;10:151-154.
3. Carstairs SD, Tanen DA, Duncan TD, et al. Computed tomographic angiography for the evaluation of aneurysmal subarachnoid hemorrhage. *Acad Emerg Med*. 2006;13:486-492.
4. McCormack RF, Hutson A. Can computed tomography angiography of the brain replace lumbar puncture in the evaluation of acute-onset headache after a negative noncontrast cranial computed tomography scan? *Acad Emerg Med*. 2010;17:444-451.
5. Rinkel GJ, Djibuti M, Algra A, et al. Prevalence and risk of rupture of intracranial aneurysms: a systematic review. *Stroke*. 1998;29:251-256.
6. Mettler FA Jr, Huda W, Yoshizumi TT, et al. Effective doses in radiology and diagnostic nuclear medicine: a catalog. *Radiology*. 2008;248:254-263.
7. Brenner DJ, Doll R, Goodhead DT, et al. Cancer risks attributable to low doses of ionizing radiation: assessing what we really know. *Proc Natl Acad Sci U S A*. 2003;100:13761-13766.
8. Brenner DJ, Hall EJ. Computed tomography—an increasing source of radiation exposure. *N Engl J Med*. 2007;357:2277-2284.
9. Bottinor W, Polkampally P, Jovin I. Adverse reactions to iodinated contrast media. *Int J Angiol*. 2013;22:149-154.
10. Rao QA, Newhouse JH. Risk of nephropathy after intravenous administration of contrast material: a critical literature analysis. *Radiology*. 2006;239:392-397.

TRIED AND TRUE AND STILL THE BEST: LUMBAR PUNCTURE, NOT COMPUTED TOMOGRAPHY ANGIOGRAM, FOR THE DIAGNOSIS OF SUBARACHNOID HEMORRHAGE

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The traditional evaluation for a suspected subarachnoid hemorrhage is an unenhanced CT scan of the brain, followed by a lumbar puncture if the CT does not reveal the headache's cause. The CT–lumbar puncture approach is very sensitive in detecting subarachnoid hemorrhage. In a large prospective cohort study, CT–lumbar puncture exhibited 100% sensitivity in identifying subarachnoid hemorrhage.[1] Furthermore, this approach may provide clues to other diagnoses such as vasculitis and nonaneurysmal bleeding events that alternative approaches may miss.[2]

The development of high-resolution CT angiography of the cerebral vessels and its ability to detect aneurysms have challenged this traditional evaluation method. Although there are increasing data about the use of CT angiography as a replacement for lumbar puncture, we argue that CT