Published in final edited form as:

Ann Emerg Med. 2016 June ; 67(6): 773–774. doi:10.1016/j.annemergmed.2014.03.009.

Computed Tomography Angiography of the Head is a reasonable next test following a Negative Non-contrast Head Computed Tomography in the Emergency Department work up of Subarachnoid Hemorrhage

Marc A. Probst, MD and Jerome R. Hoffman, MD, MA

UCLA Emergency Medicine Center, School of Medicine, University of California, Los Angeles, Los Angeles, CA, USA

Although subarachnoid hemorrhage (SAH) is rare, identifying a sentinel bleed is one of the most beneficial things an Emergency Physician (EP) can accomplish. For this discussion, we assume that a negative non-contrast computed tomography (CT) scan of the head is inadequate to rule out a sentinel SAH, and must be followed by another test; traditionally- a lumbar puncture (LP). We argue that following a non-diagnostic CT, CT angiography (CTA) is an acceptable alternative in patients with a reasonable prior probability of SAH.

Although the sensitivity of LP for SAH approaches 100%, LP has other suboptimal characteristics. It is invasive, painful, and often causes considerable patient anxiety, such that some patients will leave against medical advice if given no other choice. Not infrequently LP causes a significant postdural puncture headache, the incidence of which is estimated to range from 10–40%[1]. This complication can require medical therapy, epidural blood patch and even admission. (The literature is unfortunately not helpful regarding the frequency of any of these.) LP results are often inconclusive, mostly because of traumatic taps (in 15–20%) – and neither arbitrary cutoffs for red blood cell count, change in counts between tubes, nor evaluation of xanthochromia can resolve this problem[2]. Lastly, LP can be technically difficult, depending on patient body habitus, and is time-consuming for the EP, which can interfere with the care of other acutely ill patients.

Substituting CTA for LP has several advantages. It is painless and non-invasive, and can be performed very rapidly; from the EP standpoint, it requires little time. Diagnostically, it can identify other important causes of worrisome headache (e.g. venous sinus thrombosis, ischemic stroke, and arteriovenous malformation), even if SAH is not present, albeit while forgoing CSF analysis [3]. A recently published mathematical probability model suggests

Corresponding Author and Reprints: Marc A. Probst, MD, UCLA Emergency Medicine Center, School of Medicine, University of California, Los Angeles, 924 Westwood Blvd., Suite 300, Los Angeles, CA 90024, USA, Telephone: 310-666-3834, mprobst@gmail.com.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Conflicts of interest: There are no other conflicts of interest.

that this strategy would have a sensitivity of 99.5% for aneurysmal SAH and is eminently reasonable for most such patients[4].

There are important disadvantages of CTA. 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 vast majority of these will never cause a clinical problem. Thus, approximately one in 50 patients being evaluated for possible SAH, in whom SAH 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. This could lead to harm from unnecessary neurosurgical intervention. Fortunately, this problem can be mitigated – simply by following any CTA that shows an aneurysm, but no visible bleeding, with an LP!

The second major concern with CTA is increased radiation. 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 very difficult to achieve but is certainly not zero[7]. Nonetheless, extrapolation from epidemiologic data suggest that the lifetime attributable risk of death from cancer associated with a single CT head is less than 0.01% for individuals over 25 years old[8]. While obviously important, this risk is quite small, with a number needed to harm of 10,000, and even less in older adults – who comprise the majority of those worked up for SAH.

Thirdly, CTA 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 over time since the advent of nonionic, low-osmolality contrast formulations[9]. Recent reports estimating the incidence of contrast-induced nephropathy from CTA of the head suggest that the risk of clinically significant, patient-oriented adverse outcomes is negligible[10].

In sum, we don't argue that CTA is superior to LP as a next test after a negative non-contrast CT head, but rather that it is an acceptable alternative diagnostic strategy in adults who are at risk for SAH. We don't mean to suggest that routinely adopting an approach involving CTA is better than adopting one involving LP ... but neither would we argue the opposite. Rather, we propose that a third approach, centered on shared decision-making, is the one that should be adopted: after informing our patient about each of these perfectly reasonable approaches, we help her choose, based on her own values and preferences.

Acknowledgments

Grant funding: This work was supported by the National Heart, Lung, And Blood Institute of the National Institutes of Health under Award Number F32 HL120466 (Dr. Probst). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health or the Robert Wood Johnson Foundation.

References

1. Evans RW. Complications of lumbar puncture. *Neurol Clin.* 1998; 16:83–105. [PubMed: 9421542]
2. Shah KH, Richard KM, Nicholas S, Edlow JA. Incidence of traumatic lumbar puncture. *Acad Emerg Med.* 2003; 10:151–154. [PubMed: 12574013]
3. Carstairs SD, Tanen DA, Duncan TD, Nordling OB, Wanebo JE, Paluska TR, et al. Computed tomographic angiography for the evaluation of aneurysmal subarachnoid hemorrhage. *Acad Emerg Med.* 2006; 13:486–492. [PubMed: 16551778]
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. [PubMed: 20370785]
5. Rinkel GJ, Djibuti M, Algra A, van Gijn J. Prevalence and risk of rupture of intracranial aneurysms: a systematic review. *Stroke.* 1998; 29:251–256. [PubMed: 9445359]
6. Mettler FA Jr, Huda W, Yoshizumi TT, Mahesh M. Effective doses in radiology and diagnostic nuclear medicine: a catalog. *Radiology.* 2008; 248:254–263. [PubMed: 18566177]
7. Brenner DJ, Doll R, Goodhead DT, Hall EJ, Land CE, Little JB, 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. [PubMed: 14610281]
8. Brenner DJ, Hall EJ. Computed tomography--an increasing source of radiation exposure. *N Engl J Med.* United States. 2007;2277–2284.
9. Bottinor W, Polkampally P, Jovin I. Adverse Reactions to Iodinated Contrast Media. *Int J Angiol.* 2013:149–154. [PubMed: 24436602]
10. Rao QA, Newhouse JH. Risk of nephropathy after intravenous administration of contrast material: a critical literature analysis. *Radiology.* 2006; 239:392–397. [PubMed: 16543592]