



DIAGNOSTIC IMAGING UPDATE

URA Physicians

Mark S. Asay, MD
 Carl M. Black, MD
 S. Douglas Brown, MD
 Seth Y. Cardall, MD
 John S. Collins, MD
 Daniel L. Corey, MD
 David R. Cottam, MD
 Tyler L. Crawford, MD
 John A. Dana, MD
 Val D. Dunn, MD
 Gary V. Halversen, MD
 Roy C. Hammond, MD
 Daniel J. Hatch, MD
 Dennis K. Heaston, MD
 Kurtis R. Kendell, MD
 Jeffrey S. McClellan, MD
 Matthew A. McNairy, MD
 Ryan B. Nielsen, MD
 Matthew E. Nokes, MD
 Robin R. Ockey, MD
 J. Daniel Rasband, MD
 Thomas B. Sanders, MD
 Kimball B. Taylor, MD
 S. Douglas Wing, MD, FACR

For questions, or to
 schedule a consultation
 please contact
 Utah Radiology Associates:

801.357.7056

24/7 Consultation

IMAGING MANAGEMENT OF SUSPECTED AND CONFIRMED NONTRAUMATIC SUBARACHNOID HEMORRHAGE

Emergency presentation of headache is a common clinical scenario. Of the most dangerous pathologic entities included in the differential diagnosis of headaches is subarachnoid hemorrhage secondary to a ruptured aneurysm, bleeding dural fistula or arteriovenous malformation. Up to 16% of emergency department patients presenting with headache are diagnosed with non traumatic subarachnoid hemorrhage. 80% of non-traumatic subarachnoid hemorrhage patients have a cerebral aneurysm or AVM/fistula as the source of hemorrhage. Mortality rates associated with non traumatic subarachnoid hemorrhage is significant. Based on clinical grade the mortality rates are: Grade 1 (1%), Grade 2 (5%), Grade 3 (19%), Grade 4 (42%), Grade 5 (77%) (see figure 1). Traditionally the work up of these patients has included a unenhanced CT head and/or a lumbar puncture. In patients with confirmed subarachnoid hemorrhage a diagnostic cerebral angiogram would be performed to identify the source of hemorrhage.

Relative recent advances with noninvasive imaging, particularly CT angiography (CTA) has raised the following question: what is the role of lumbar puncture and digital subtraction angiography (DSA) in the current imaging workup of these patients?

Suspected Nontraumatic Subarachnoid Hemorrhage

Unenhanced CT and lumbar puncture are excellent tests for evaluating subarachnoid hemorrhage. Combined the two tests have a 100% negative predictive value. CT alone has a high sensitivity with current CT scanners demonstrating a 98% sensitivity for subarachnoid hemorrhage within the first 12 hours (see figure 2). The sensitivity of CT drops over time secondary to resorption of subarachnoid hemorrhage. CT sensitivity within the first 24 hours is reported at 93%, with sensitivity dropping to 85% at up to 5 days. CT imaging and lumbar puncture are exams that can be performed at nearly

Figure 1 - Grading Scales for Subarachnoid Hemorrhage

Grade	World Federation of Neurosurgical Societies Scale*	Hunt and Hess Scale
1	15	Asymptomatic or mild headache and nuchal rigidity
2	13-14 with no focal deficit	Moderate-to-severe headache, nuchal rigidity, and cranial nerve palsy
3	13-14 with focal deficit	Lethargy, confusion, or mild focal deficit
4	7-12 with or without focal deficit	Stupor, moderate-to-severe hemiparesis, and early decerebrate rigidity
5	3-6 with or without focal deficit	Deep coma, decerebrate rigidity, and moribund appearance

* The numbers represent points on the Glasgow Coma Scale, on which scores can range from 3 to 15, with higher scores indicating better function.

n engl j med 355:25 www.nejm.org December 21, 2006

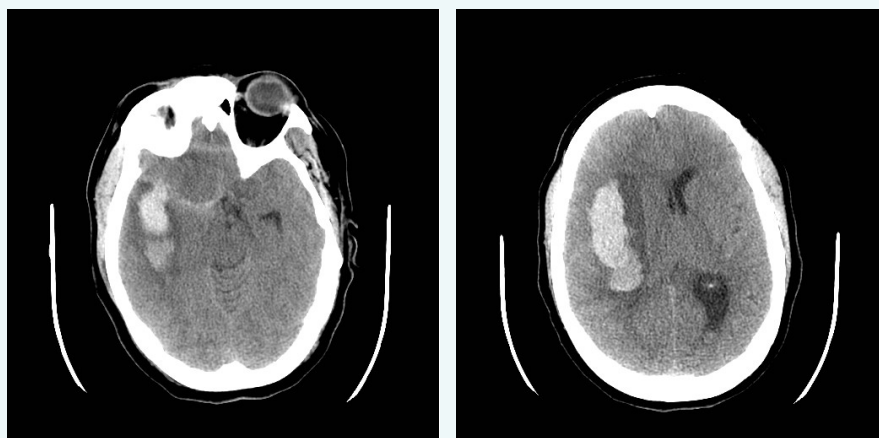
Imaging Management of Suspected and Confirmed Nontraumatic Subarachnoid Hemorrhage

every institution. There are several challenges to performing a lumbar puncture including: 1) time consuming, 2) technically challenging (uncooperative patients, post op patients, patients with larger BMI, bloody tap), 3) Invasive test with potential complications (spinal headache). Equivocal lumbar puncture results are reported in up to 15-20% of patients. Unenhanced CT combined with CTA has a negative predictive value of 99% for subarachnoid hemorrhage. In patients with complicating factors where a lumbar puncture can not be performed or patients with equivocal lumbar puncture results CT combined with CTA provides a reliable alternative approach.

Confirmed Nontraumatic Subarachnoid Hemorrhage

Digital subtraction angiography is the gold standard for identifying a source of nontraumatic subarachnoid hemorrhage. DSA is an invasive test with a reported complication rate 2.5%. Current CTA with multiplanar reformats, MIP, and the ability to generate 3D volume rendered data has provided a rapid noninvasive and relative ubiquitous exam to replace or augment DSA (see figure 3 and 4). CTA has a reported sensitivity of 98% and specificity of 100% for detecting intracranial aneurysms. CTA is effective tool used by many institutions to triage aneurysm patients to either endovascular coiling or clipping. CTA is not perfect. On documented cases CTA is insensitive in evaluating blister type aneurysms. There is also disagreement of the role of CTA in evaluating patients with perimesencephalic hemorrhage, a specific pattern of non-traumatic subarachnoid hemorrhage. The majority of perimesencephalic hemorrhage patients have a more benign clinical course, and this subarachnoid hemorrhage is felt to be

Figure 2 - Subarachnoid Hemorrhage with an aneurysmal pattern.



A) axial unenhanced CT demonstrates subarachnoid hemorrhage within the right sylvian fissure and right supraventricular cistern. Intraparenchymal hemorrhage adjacent to the right sylvian fissure with associated mass effect and vasogenic edema. This pattern suggests a ruptured right middle cerebral artery aneurysm.

B) Right to left subfalcine shift and left lateral ventricle enlargement.

Figure 5 - Ruptured right middle cerebral artery bifurcation aneurysm.



A) CTA coronal MPR demonstrates a right MCA bifurcation aneurysm.

B) CTA 3D volume rendered image demonstrates the same right MCA bifurcation aneurysm.

a venous hemorrhage. However, approximately 10% of patients with this perimesencephalic pattern of hemorrhage have a posterior circulation aneurysm as the source of hemorrhage.

Despite these imperfections with CTA, it remains the front line angiographic exam and often averts the invasive DSA. A recent article published in American Journal of Neuroradiology examined the role of DSA in nontraumatic subarachnoid hemorrhage where the initial CTA was negative. These results confirm a high negative predictive value for CTA and highlight which patients would still benefit from additional evaluation with DSA following negative initial CTA. (see figure 5 for this proposed imaging approach).

Imaging Management of Suspected and Confirmed Nontraumatic Subarachnoid Hemorrhage



Figure 4 - AP DSA image re-demonstrating the right MCA bifurcation aneurysm

CT combined with CTA is an effective imaging strategy for evaluating suspected nontraumatic subarachnoid hemorrhage, with a negative predictive value of 99%. This level of certainty may negate the performance of lumbar puncture in patients who present early and are more prone to lumbar puncture complications. In addition with the use of quality CTA in patients with confirmed nontraumatic subarachnoid hemorrhage, we can effectively and expeditiously triage patients to the appropriate treatment or further diagnostic evaluation.

References

1. Provenzale JM, Hacin-Bey L. CT evaluation of subarachnoid hemorrhage: a practical review for the radiologist interpreting emergency room studies. *Emergency Radiology* (2009) 16: 441-451.
2. 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? *Academic Emergency Medicine* Vol 17, No 4: 444-451.
3. Agid R, et al. Negative CT Angiography Findings in Patients with Spontaneous Subarachnoid Hemorrhage: When Is Digital Subtraction Angiography Still Needed? *American Journal of Neuroradiology* (2010) 31: 696-705.

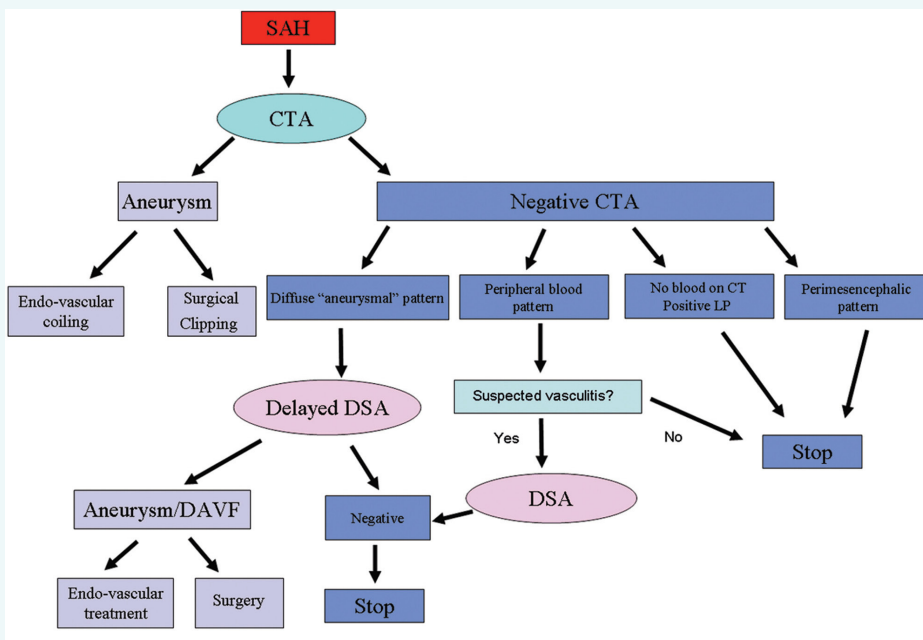


Figure 5 - Proposed imaging approach for patients with nontraumatic subarachnoid hemorrhage. *AJNR Am J Neuroradiol* 31:696-705 Apr 2010.



Meet Our Neuroradiologists



Carl M Black, M.D. Dr. Carl Black's primary professional areas of focus include interventional radiology and neuroradiology. His expertise includes treatment of disorders of the arterial and venous circulation, acute stroke intervention, carotid artery stenting, therapeutic embolization (i.e. oncologic, vascular malformations, post traumatic bleeding), treatment of superficial venous insufficiency and catheter-directed thrombolysis. He also performs spine intervention for pain management, including treatment of vertebral body compression fractures. Dr. Black is fellowship-trained with board certifications in interventional radiology and neuroradiology.

Dr. Black graduated from the George Washington University (GWU) School of Medicine and Health Sciences. He then completed a transitional internship at Georgetown University followed by residency in diagnostic radiology at GWU where he served as Chief Resident and was elected to the Alpha Omega Alpha (AOA) Honor Medical Society. Dr. Black then trained as a fellow in neuroradiology at the Barrow Neurological Institute and in interventional radiology at the University of Iowa Hospitals and Clinics.

Dr. Black has published and presented many original peer-reviewed scientific articles on diagnostic and interventional radiology. As a fellow in interventional radiology he was awarded the Memorial Gold Medal Research Award by the Association of University Radiologists for his research of carbon dioxide as an intravascular contrast agent. Following four years in the US Air Force, Dr. Black joined Utah Radiology Associates. He is a member of the Society of Interventional Radiology and a senior member of the American Society of Neuroradiology.



Daniel L. Corey, M.D. Dr. Daniel Corey is fellowship-trained and board-certified in diagnostic radiology, and his expertise is Neurological Imaging. After graduating from medical school at The University of Utah Medical Center, he completed a residency in diagnostic radiology followed by further training in Neuroradiology at Oregon Health Science University. Dr. Corey holds a Doctorate of Physical Therapy from Creighton University where he graduated Summa Cum Laude.

Dr. Corey has been involved in research including neurologically-associated intravascular lymphomatosis; anomalous hepatic vein drainage in the right atrium; the effectiveness of strain/counterstrain; and others involving needs of emergency department patients.

He is a member of Radiological Society of North America, American Roentgen Ray Society, American Society of Neuroradiology, and American Medical Association.



Thomas B. Sanders, M.D. Dr. Thomas Sanders is fellowship trained in Neuroradiology and board certified in Diagnostic Radiology. Dr. Sanders is skilled in interpreting and acquiring medical imaging with a emphasis in brain, spine, skull base and neck imaging.

After graduating magna cum laude in his undergraduate work, Dr. Sanders attended the Medical College of Wisconsin. Following medical school he completed both a transitional internship and a diagnostic radiology residency at Aurora St. Luke's Medical Center in Milwaukee, Wisconsin. As a senior resident he served as chief resident.

Following residency he obtained his board certification from the American Board of Radiology. Subsequently he entered a two year diagnostic neuroradiology fellowship and the Barrow Neurological Institute in Phoenix, Arizona. His professional associations include the Radiological Society of North America, American College of Radiology, American Society of Neuroradiology.



S. Douglas Wing, M.D., FACR Dr. S. Douglas Wing is an experienced practitioner and teacher of diagnostic radiology. He was a faculty member at the University of Utah Medical School for five years, where he taught radiology residents and medical students. He published and presented a variety of papers related to neuroradiology imaging. At Utah Valley Hospital, he has served as president of the medical staff, chair of the Continuing Medical Education Committee, and chair of the Department of Radiology. He has also been president of the Utah State Radiological Society, and counselor for the Radiological Society of North America. He is a fellow in the American College of Radiology.

Dr. Wing attended the University of Utah College of Medicine, where he was elected to Alpha Omega Alpha Honor Medical Society and received the Florence Strong Award for academic excellence and patient care. After earning his medical degree, he remained at the University of Utah for a straight medical internship. He then attended the University of California San Francisco to complete a residency in diagnostic radiology, including serving as chief resident. This was followed by an NIH fellowship in neuroradiology at UCSF. Dr. Wing is board certified in diagnostic radiology, and is a Senior Member in the American Society of Neuroradiology.