Imaging of Subdural Hematomas

Jason J. Carroll, MD[a,*], Sean D. Lavine, MD[b,c], Philip M. Meyers, MD[d]

KEYWORDS

• Imaging • Subdural • Hematoma • CT • MRI

KEY POINTS

- In the early postoperative period, noncontrast head CT is most commonly used to evaluate for potential complications.
- CT is widely available, fast, relatively inexpensive, and accurate at identifying most postoperative complications.
- Intracranial air in the early postoperative period can cause artifact on MRI.
- CT is sensitive for the identification of new intracranial hemorrhage, new mass effect and herniation, tension pneumocephalus, and calvarial fractures.
- Although MRI is less often used in the immediate postoperative period, it is much more sensitive for the detection of acute ischemia and infection.
- The choice to use MRI in the postoperative setting should be driven by the clinical scenario; if acute ischemia or infection is suspected clinically, MRI should always be considered.

BACKGROUND ON IMAGING OF SUBDURAL HEMATOMAS

Historical Imaging Techniques

The imaging of subdural hematoma has evolved significantly. Before modern cross-sectional techniques, such as computed tomography (CT) and MRI, radiography of intracranial pathology generally relied on distortion of normal structures to suggest an intracranial process.[1] Early techniques including plain film radiography, ventriculography, pneumoencephalography, and catheter angiography were limited in the evaluation of the brain parenchyma and surrounding structures given their inherently poor soft tissue resolution. Therefore, the intracranial structures, including the brain parenchyma and ventricles, had the same density on plain film radiography making evaluation for intracranial hemorrhage, tumors, and other intracranial pathologies impossible to visualize. With the exception of plain film radiography, these tests were generally invasive. For example, ventriculography involved drilling a burr hole and directly injecting air into the ventricular system.[2] Pneumoencephalography also relied on similar principles, although the air was instilled into the subarachnoid space of the spine rather than directly into the ventricular system. Both techniques relied on plain film radiography and tomography to evaluate the ventricles to determine ventricular contour irregularities suggesting a mass occupying lesion.[3–5] These studies were uncomfortable for the patient, often inducing vertigo, nausea, and vomiting.

No financial or commercial conflicts of interest for the above listed authors.

[a] Department of Neurological Surgery, Neurological Institute, New York Presbyterian Hospital-Columbia University Medical Center, 710 West 168 Street, New York, NY 10032, USA; [b] Neurointerventional Services, The Valley Hospital Ridgewood, Ridgewood, NJ, USA; [c] Neuroendovascular Services, Department of Neurological Surgery, Neurological Institute, New York Presbyterian Hospital, 710 West 168 Street, New York, NY 10032, USA; [d] Neuroendovascular Services, Department of Neurological Surgery, Neurological Institute, Children's Hospital of New York, New York Presbyterian Hospital, 710 West 168 Street, New York, NY 10032, USA
* Corresponding author.
E-mail address: jjc2272@cumc.columbia.edu

Neurosurg Clin N Am ■ (2016) ■–■
http://dx.doi.org/10.1016/j.nec.2016.11.001
1042-3680/16/

Complication rates were high, and included headache, neck stiffness, meningitis/ventriculitis, altered consciousness, tachycardia, and focal neurologic signs. For these reasons, repeat studies were often not performed given the level of patient discomfort and risks, which limited the evaluation of disease progression over time.[6] Although catheter angiography depicted the cerebral blood vessels with great detail, it too included substantial risks, was plagued by inherently low soft tissue resolution, and also relied on distortion or displacement of the cerebral vasculature to suggest an underlying space-occupying lesion. CT and MRI have supplanted other procedures and rendered most obsolete for the evaluation of intracranial pathology because of ease of use, tremendous soft tissue resolution, safety, and availability.

Current Imaging Recommendations

Noncontrast CT has become the accepted standard of care for the initial evaluation of patient's with suspected subdural hematoma because of widespread availability, rapid acquisition time, and noninvasive nature. Advanced-generation CT scanners now use multiple detectors, helical acquisition, dual-source, and dual-energy techniques, further improving the quality of CT scans while potentially decreasing the radiation dose to patients depending on the type of study performed. MRI generally has a more limited role in the evaluation of acute intracranial hemorrhage, particularly when evaluating subdural hematoma, for practical reasons including availability in most emergency departments. However, MRI offers important features in determining potential secondary causes of subdural hematomas, such as dural-based neoplasms. There is no longer a role for plain film radiography, ventriculography, or pneumoencephalography in the evaluation of traumatic or nontraumatic intracranial hemorrhage.[7]

IMAGING CHARACTERISTICS

General Features

Subdural hematoma is defined as an extra-axial collection of blood products in the subdural space, which is a potential space between the arachnoid and dura mater. The dura mater is the outermost meningeal layer covering the brain parenchyma. The dura is a thin, fibrous covering that extends over the entire brain and is continuous with the periosteum. The dura is reflected along the medial cerebral hemispheres where two layers form the falx cerebri. Similarly, the dura is reflected along the undersurface of the cerebral hemispheres forming the tentorium cerebelli, which divides the supratentorial and infratentorial compartments. The dural venous sinuses travel between the two dural leaflets along the falx cerebri and tentorium cerebelli. Cortical veins draining the brain parenchyma empty into the dural venous sinuses by crossing the subdural space, hence the term bridging veins. Subdural hematomas are usually caused by tearing of these bridging veins.

Trauma is the most common cause of subdural hematoma.[7] Sudden acceleration/deceleration of the head, rapid head rotation, or direct laceration from skull fractures or penetrating projectiles can tear bridging cortical veins. Spontaneous atraumatic subdural hematomas are particularly common in the elderly and people with alcoholism because of the increased incidence of cerebral atrophy in these populations. Cerebral atrophy causes the extra-axial spaces, including the subdural space, to enlarge and the bridging veins to elongate making them more susceptible to injury.[8] Spontaneous subdural hematomas can also occur in patients with coagulopathy and those taking anticoagulant or antithrombotic medications, such as aspirin, clopidogrel, or warfarin.[9] Less common causes of subdural hematoma include dural-based neoplasms, such as meningiomas, hemangiopericytomas, or metastases.[10,11] Intracranial hypotension caused by cerebrospinal fluid (CSF) leak following cranial, spinal, or paranasal sinus surgery is another uncommon cause of atraumatic subdural hematoma.[12,13] Additional rare causes of subdural hematoma include hyponatremic dehydration and dural venous sinus thrombosis.[14–20] In rare circumstances the subdural hematoma is caused by injury to a cortical artery or ruptured vascular lesion, such as an aneurysm or vascular malformation (**Fig. 1**).[21–26] In some circumstances, no clear cause of the subdural hematoma is identified (**Box 1** and **2**).

Anatomic barriers determine the imaging appearance of subdural hematomas. A crescentic extra-axial collection overlying the cerebral convexities is the classic imaging appearance of subdural hematoma. Subdural hematomas often cross calvarial sutures (by contrast with epidural hematomas); however, they rarely cross midline because of continuity of the dural membrane with the falx. Similarly, subdural collections often marginate the falx cerebri medially and tentorium cerebelli inferiorly (**Fig. 2**). Smaller collections of blood can be seen along either the falx cerebri or tentorium cerebelli alone. Without these anatomic barriers, small extra-axial collections overlying the cerebral hemispheres may be difficult to localize accurately into the correct anatomic extra-axial space: epidural, subdural, or subarachnoid. Subdural hematomas tend to distribute diffusely