Imaging of Cerebrospinal Fluid Rhinorrhea and Otorrhea

Mahati Reddy, MD, Kristen Baugnon, MD*

KEYWORDS

• CSF leak • Idiopathic intracranial hypertension (IIH) • Skull base fractures • Cisternogram

KEY POINTS

- Any clinically suspected cerebrospinal fluid (CSF) rhinorrhea or otorrhea should first be confirmed with testing for β2-transferrin, a protein specific to the CSF.
- High-resolution computed tomography (CT) imaging through the sinuses and mastoids should be the first step to diagnose the possible site of a CSF leak.
- CT cisternogram can be helpful to confirm the site of a leak in patients with multiple osseous defects on CT and an active leak.
- Magnetic resonance cisternogram is helpful in patients with intermittent leaks or suspected meningoencephaloceles.
- Morphologic features suggesting underlying idiopathic intracranial hypertension should be mentioned on imaging of suspected CSF leak, because this can alter the patient's management.

INTRODUCTION

A skull base cerebrospinal (CSF) leak or fistula is an abnormal communication of the sterile subarachnoid space with the sinonasal or tympanomastoid cavities, and presents clinically with clear rhinorrhea or otorrhea, caused by the presence of both an osseous and a dural defect. The flora of the sinonasal cavity and the middle ear create a conduit for the spread of infection that often results in meningitis, with an approximately 19% lifetime risk of meningitis in patients with persistent CSF rhinorrhea.[1] Despite advances in antibiotic therapy, mortality from bacterial meningitis in adults remains up to 33%, with severe morbidity among survivors, including seizure disorders, encephalopathy, and cranial nerve deficits.[2] The high risk of life-threatening complications underscores the importance of early detection, accurate diagnosis, and timely repair of CSF leaks. Endoscopic approaches to CSF leak repair are replacing open transcranial and transfacial methods because of similar rates of success, with significantly lower complication rates of wound infection, sepsis, and meningitis.[3,4] Especially in the setting of an endoscopic repair, a thorough radiologic investigation is imperative to determine the precise location of the fistula, define the dimensions of the osseous defect, and evaluate the subjective anatomy of the area. This process enables surgeons to plan the surgical approach, graft, and closure technique, and to avoid an open craniotomy.[5]

Not only is imaging essential in determining the site of a CSF leak but it can also aid in determining the underlying cause. CSF leaks can be traumatic or nontraumatic, with most nontraumatic leaks seen in the setting of idiopathic intracranial hypertension (IIH), also known as spontaneous leaks.[6,7] This article begins with a description of imaging

Disclosure: None.
Department of Radiology and Imaging Sciences, Emory University School of Medicine, Emory University Hospital, 1364 Clifton Road Northeast, Atlanta, GA 30322, USA
* Corresponding author.
E-mail address: kmlloyd@emory.edu

Radiol Clin N Am 55 (2017) 167–187
http://dx.doi.org/10.1016/j.rcl.2016.08.005

techniques used to diagnose and characterize the site of a CSF leak and then details the pathophysiology and associated imaging findings in traumatic and spontaneous leaks. In addition, it discusses some challenges in the diagnosis of initial and recurrent leaks with an emphasis on information that is most consequential to referring surgeons.

IMAGING PROTOCOLS

The first diagnostic study to evaluate a patient with CSF rhinorrhea or otorrhea and suspected CSF leak is testing a sample of the fluid for β2-transferrin, a protein specific to the CSF, because this is the most reliable confirmatory test for a CSF leak.[8] As discussed previously, rhinorrhea can be a sign of a defect along either the paranasal sinuses or mastoids. Frank otorrhea draining from the external auditory canal in the setting of a tegmen defect within the middle cranial fossa is rare, unless there is a perforation of the tympanic membrane (ie, in the setting of trauma), or a tympanostomy tube. Various methods of testing for β2-transferrin report sensitivities of 87% to 100% and specificities of 71% to 94%.[9] Patients with intermittent leaks may be able to collect an adequate volume of sample themselves over the course of a week, if necessary, without storage restrictions to prevent protein degradation.[10] Although not widely used in the United States, beta trace protein is another CSF marker, and some recent studies report that it has a higher sensitivity and specificity than β2-transferrin with lower cost and faster turnaround time.[9,11,12] Once the leak is confirmed, localization and characterization can be achieved with radiologic evaluation.

COMPUTED TOMOGRAPHY

High-resolution CT (HRCT) of the paranasal sinuses and mastoids should be the first line of imaging because computed tomography (CT) is the best modality to delineate osseous anatomy with the greatest spatial resolution to pinpoint a site of bony dehiscence. HRCT has a reported sensitivity of 88% to 95% in identifying the site of skull base defect after the presence of CSF leak is confirmed by β2-transferrin analysis.[13–16] In a single retrospective study at our institution, CT correctly predicted the site of leak in 100% of the cases when 0.625-mm axial images were available and multiplanar reformations could be generated.[17] In addition to excellent accuracy, HRCT provides unparalleled delineation of the remaining osseous sinonasal anatomy for surgeons to plan their operative approach and allows the use of an intraoperative image guidance system.[18] Patients should be scanned with multidetector row CT in the supine position with a field of view to include the paranasal sinuses and temporal bones. Continuous thin-section axial images of submillimeter (ie, 0.625 mm) collimation (volumetric) should be reconstructed in the bone algorithm, and sagittal and coronal reconstructions of the raw data should be performed.[17,19] One of the greatest strengths of HRCT in the evaluation of CSF leak is that an active leak does not need to be present at the time of imaging to be able to identify an osseous defect. However, if the patient has multiple osseous defects, it can be challenging to determine which defect is the definite source of the CSF leak, because the presence of an osseous defect is not always associated with a concomitant dural dehiscence. However, if only 1 osseous defect is identified and the location of the suspected leak on imaging corresponds with the clinical symptoms, no additional imaging is needed, and the patient can proceed to surgical repair.[20]

Computed Tomography Cisternography

Contrast-enhanced CT cisternography (CTC) is performed by instilling intrathecal nonionic myelographic iodinated contrast and scanning the sinuses in the prone and supine positions, with supine images also obtained before contrast injection for the purposes of comparison. In a positive study, there is extracranial fluid or soft tissue density adjacent to an osseous defect showing 50% or greater increase in Hounsfield units on the postcontrast scan compared with the precontrast scan, suggestive of interval contrast pooling. When introduced in 1977, CTC was considered the study of choice to evaluate CSF fistulae, but it is now selectively used as a problem-solving tool in specific scenarios, primarily in the setting of multiple osseous defects on CT, to determine the site of leak.[21,22] CTC has a wide range of reported sensitivities of 33% to 100% and specificity of approximately 94%.[8,13,23–25] The main limitation of CTC is that patients have to be actively leaking, or able to elicit a leak, at the time of examination. Low rates of sensitivity are predominantly attributed to imaging in the absence of an active leak, with other potential causes being obscuration of small leak in the setting of high-density contrast media adjacent to high-density bone and high viscosity of contrast media prohibiting leakage through a fistulous tract.[25,26] The disadvantages of CTC include high radiation dose related to multiple scans, inherent risk of a lumbar puncture, and potential adverse outcome from iodinated contrast.