

Cerebrospinal Fluid Leaks: A Case Series of Sinus Opacification on Computed Tomography (CT) Imaging

Andrew Wilson, M.S.¹, Carissa Walter, MPH², Lauren Clark, M.S.³, Peng Shi, M.A.³, Mitchell Guenther, M.D.²

¹Kansas City University College of Osteopathic Medicine, Kansas City, MO

²University of Kansas Medical Center, Kansas City, KS
Department of Radiology

³University of Kansas School of Medicine, Kansas City, KS
Department of Biostatistics

Received Dec. 20, 2021; Accepted for publication April 8, 2022; Published online June 20, 2022
<https://doi.org/10.17161/kjm.voll5.16299>

ABSTRACT

Introduction. Cerebrospinal fluid (CSF) leaks occur when fluid seeps through a dural or skull base defect, typically in the nose or ear. CSF leaks commonly are identified and diagnosed by use of computed tomography (CT) and CT cisternogram. CT findings suggestive of a CSF leak include a skull-based bone defect along with opacification of the contiguous sinus. This study examined a series of CSF leaks on CT imaging to document imaging findings.

Methods. A single-institution retrospective review of cases of CSF leak diagnosed by CT maxillofacial or CT cisternogram from January 1, 2008 to March 12, 2018 was performed. Patient demographics, history, imaging findings, and treatment were recorded.

Results. Thirty-nine patients met the inclusion criteria for the study. The average age was 51, and a large majority were female (76.9%). Among the 25 patients in which it was reported, the mean size of skull base defect was 0.472 cm. Of the 39 total cases, 27 patients (69.2%) presented with sinus opacification on CT imaging.

Conclusions. Radiologists should be aware of the possibility of notable sinus opacification observable on CT when investigating a potential CSF leak. Opacification may vary in both location and size depending on the nature and location of a CSF leak. Further research is needed to draw a correlation between sinus opacification seen on CT scan and the diagnosed origin of a CSF leak. *Kans J Med 2022;15:205-207*

INTRODUCTION

Cerebrospinal fluid (CSF) leaks occur when CSF seeps through a dural or skull base defect, typically in the nose or ear.¹ Trauma is the most common cause of CSF leaks, with prior studies reporting 80% of CSF leaks were secondary to trauma, with a smaller portion occurring non-traumatically or spontaneously.^{1,2} Spontaneous CSF leaks increasingly have been diagnosed and linked with obesity.³ Complications of CSF leaks can be severe and may result in meningitis, brain herniation, or coma, necessitating early detection.¹ Although some CSF leaks are managed conservatively, treatment typically requires endoscopic nasal surgery.

Imaging plays a pivotal role in the diagnosis and treatment of CSF leaks. While laboratory workup can confirm a CSF leak by the presence of beta 2 transferrin in the rhinorrhea, it is unable to locate the origin of the leak.⁴ CSF leaks can be identified on several imaging modalities. Computed tomography (CT) is often the first study obtained due to its ability to characterize osseous defects.⁵ Fine detail CT scans, with 1-2

mm sections through the skull base, can identify the location of the CSF leak and show small bony irregularities and fractures.⁴ CT scans also have demonstrated accurate correlation with intraoperative endoscopic findings.⁶ While high-resolution CT is typically the initial screening study, CT cisternogram is also useful in diagnosing CSF leaks if there are multiple skull base defects or if the initial CT scan is negative.^{4,5,7,8}

The goal of imaging CSF leaks is to confirm the diagnosis, determine the cause, and localize and characterize the defect.⁵ CT findings suggestive of a CSF leak include a skull-based bone defect along with opacification of the contiguous sinus. The most common location for CSF leaks is the anterior cranial fossa following a defect in the cribriform plate, although one also may arise from the ethmoid, sphenoid, or frontal sinuses. Size and imaging characteristics of the defect, such as adjacent soft tissue or mucosal thickening, are also important for adequate surgical planning.^{1,4,5}

Although prior research has documented that CT findings of CSF leaks include opacification of a contiguous sinus,⁵ an association between the specific type of sinus opacification and CSF leak has not been well studied. Knowing if there is a pattern between sinus opacification and CSF leaks could guide radiologist search patterns and improve accuracy of CSF leak diagnoses, particularly if they were incidental findings, which may improve timeliness of CSF leak diagnosis and influence treatment strategy. Doing so could enable patients to receive appropriate care and result in fewer complications secondary to CSF leaks. The purpose of this study was to describe imaging findings of patients with CSF leaks.

METHODS

Institutional review board approval was obtained, and patient medical records were reviewed in compliance with Health Insurance Portability and Accountability Act guidelines. A retrospective review of all patients diagnosed with a CSF leak by CT maxillofacial or CT cisternogram from January 1, 2008 to March 12, 2018 was conducted. Imaging findings and characteristics were recorded along with clinicopathologic features. Patient demographics and clinical information, including date of birth, gender, race, ethnicity, body mass index (BMI), history of intracranial hypertension, and history of skull base surgery, were obtained from the electronic medical record. Imaging and results were obtained from the Picture Archiving and Communications Systems (PACS).

RESULTS

Images from 39 patients with CSF leaks were examined. The average age was 51 years, and a large majority were female (76.9%), White (69.2%), and non-Hispanic/Latino (89.7%). The mean body mass index among patients was 36.45. Most had no history of intracranial hypertension (84.6%) and had no history of skull base surgery (79.5%, Table 1).

In 39 patients with CSF leak, 20 patients had an identifiable cause of CSF leak: seven were traumatic (18.0%), four (10.3%) were non-traumatic, and nine (23.1%) were spontaneous. The cause was unknown in

the remaining 19 (48.7%) of them. Of the 39, CSF leaks were located in the cribriform plate (30.8%), ethmoid sinus (35.9%), sphenoid sinus (33.3%), and frontal sinus (10.3%). Among the 25 patients in which it was reported, the mean size of skull base defect was 0.472 cm. A total of 30.7% of the patients were examined by CT cisternogram and 87.2% were examined by CT maxillofacial. Thirty of the 39 patients presented with elevated levels of Beta 2 transferrin; the nine remaining patients did not have this information reported.

Patients in this study had their CSF leak treated or managed in a variety of ways. Twenty-nine patients (74.4%) underwent a lumbar drain, and 31 (79.5%) underwent endoscopic nasal surgery. Five patients (12.8%) underwent open craniotomy, and two (5.1%) had their leak managed conservatively (Table 2).

Of the 39 total cases, 27 patients (69.2%) presented with sinus opacification on CT imaging. Sinus opacification was noted in the frontal (18.5%), ethmoid (7.4%), maxillary (40.7%), and sphenoid (66.7%) sinuses. Nine (33.4%) of these 27 patients had bilateral sinus opacification, and eleven (40.7%) had solitary sinus opacification. Nine patients (33.4%) had full sinus opacification compared to the remaining eighteen (66.7%) patients with partial sinus opacification (Table 3).

Table 1. Patient characteristics.

		Case Group (N = 39)
Age, mean (SD)		51.9 (15.1)
Sex, n (%)		
	Male	9 (23.1%)
	Female	30 (76.9%)
Race, n (%)		
	Asian/Pacific Islander	0
	Black	7 (18.0%)
	White	27 (69.2%)
	Other	5 (12.8%)
Ethnicity, n (%)		
	Non-Hispanic/Latino	35 (89.7%)
	Hispanic/Latino	4 (10.3%)
BMI, mean (SD)		36.45 (11.23)
History of intracranial hypertension, n (%)		
	Yes	6 (15.4%)
	No	33 (84.6%)
History of skull base surgery, n (%)		
	Yes	8 (20.5%)
	No	31 (79.5%)

DISCUSSION

There were several limitations to our study. While sinus opacification and its qualities were observable on CT for a majority of the patients in the study, there was no means of drawing a correlation between these observations and the location of the CSF leak. Without a control group, it was not possible to establish a definitive link between sinus opacification and the origin of a CSF leak. Nineteen of the 39 patients had an unknown or unidentified type of CSF leak, which barred our ability to observe for links between type of CSF leak and sinus opacification. Report of beta 2 transferrin levels to confirm CSF leak was missing for 9 of 39 patients.

Table 2. CSF leak characteristics.

		Case Group (N = 39)
Type of CSF leak, n (%)		
	Traumatic	7 (18.0%)
	Non-traumatic	4 (10.3%)
	Spontaneous	9 (23.1%)
	Unknown	19 (48.7%)
Location of CSF leak, n (%)		
	Anterior skull base	0
	Cribriform plate	12 (30.8%)
	Ethmoid sinus	14 (35.9%)
	Sphenoid sinus	13 (33.3%)
	Frontal sinus	4 (10.3%)
Mean size of skull base defect, mean (SD)*		0.472 cm (0.285 cm)
Diagnosis method of CSF leak, n (%)		
	CT cisternogram	12 (30.8%)
	CT maxillofacial	34 (87.2%)
CSF leak management, n (%)		
	Conservative management	2 (5.1%)
	Lumbar drain	29 (74.4%)
	Open craniotomy	5 (12.8%)
	Endoscopic nasal	31 (79.5%)
	Procedure Cancelled	1 (2.6%)
Elevated Beta 2 transferrin, n (%)		
	Positive	30 (76.9%)
	Negative	0
	Not reported	9 (23.1%)

*Only 25 patients reported their size of skull base defect.

Table 3. Sinus opacification characteristics.

		Patients with Sinus Opacification (N = 27)
Type of sinus opacification, n (%)		
	Frontal	5 (18.5%)
	Ethmoid	2 (7.4%)
	Maxillary	11 (40.7%)
	Sphenoid	18 (66.7%)
Bilateral sinus opacification, n (%)		
	Yes	9 (33.3%)
	No	18 (66.7%)
Solitary sinus opacification, n (%)		
	Yes	11 (40.7%)
	No	16 (59.3%)
Size of sinus opacification, n (%)		
	Full	9 (33.3%)
	Partial	18 (66.7%)

The patients included in this study had an average BMI of 36.45, which would be categorized as obese. A prior study by Quatre et al.³ discussed an association between body weight and incidence of spontaneous cerebrospinal fluid leak. Twenty-three percent of the patients in this study had a CSF leak identified as spontaneous. As obesity continues to rise as a leading health issue, physicians must remain aware of the need to identify and diagnose a spontaneous CSF leak in obese patients.

In conclusion, among the 39 cases of CSF leak in this study, nearly 70% presented with some form of sinus opacification on CT imaging. Sinus opacification can be observed in one or multiple sinuses in the presence of a CSF leak and may be bilateral or solitary as well as partial or full. Radiologists and physicians should be aware of this potential finding when evaluating a patient for a possible cerebrospinal fluid leak. As previously mentioned, timely diagnosis and treatment of CSF leak is essential to preventing further complications. More research is needed

to establish a definitive correlation between sinus opacification on CT scan and the location of a cerebrospinal fluid leak. An established association between the two will further aid physicians in making a more accurate and faster diagnosis for these patients.

REFERENCES

- ¹ Mathias T, Levy J, Fatakia A, McCoul ED. Contemporary approach to the diagnosis and management of cerebrospinal fluid rhinorrhea. *Ochsner J* 2016; 16(2):136-242. PMID: 27303222.
- ² Hasheminia D, Kalantar Motamedi MR, Hashemzahi H, Nazeri R, Movahedian B. A 7-year study of 1,278 patients with maxillofacial trauma and cerebrospinal fluid leak. *J Maxillofac Oral Surg* 2015; 14(2):258-262. PMID: 26028845.
- ³ Quatre R, Attye A, Righini CA, et al. Spontaneous cerebrospinal fluid rhinorrhea: Association with body weight and imaging data. *J Neurol Surg B Skull Base* 2017; 78(5):419-424. PMID: 28875121.
- ⁴ Lund VJ, Savy L, Lloyd G, Howard D. Optimum imaging and diagnosis of cerebrospinal fluid rhinorrhoea. *J Laryngol Otol* 2000; 114(12):988-992. PMID: 11177378.
- ⁵ Lloyd KM, DelGaudio JM, Hudgins PA. Imaging of skull base cerebrospinal fluid leaks in adults. *Radiology* 2008; 248(3):725-736. PMID: 18710972.
- ⁶ La Fata V, McLean N, Wise SK, DelGaudio JM, Hudgins PA. CSF leaks: Correlation of high-resolution CT and multiplanar reformations with intraoperative endoscopic findings. *AJNR Am J Neuroradiol* 2008; 29(3):536-541. PMID: 18079188.
- ⁷ Reddy M, Baugnon K. Imaging of cerebrospinal fluid rhinorrhea and otorrhea. *Radiol Clin North Am* 2017; 55(1):167-187. PMID: 27890184.
- ⁸ Shetty PG, Shroff MM, Sahani DV, Kirtane MV. Evaluation of high-resolution CT and MR cisternography in the diagnosis of cerebrospinal fluid fistula. *AJNR Am J Neuroradiol* 1998; 19(4):633-639. PMID: 9576647.

Keywords: cerebrospinal fluid hypovolemia, skull base, nasal sinuses, computed tomography, x-ray