Diagnostic dilemma: cerebrospinal fluid leak from spontaneous intracranial hypotension with concurrent skull base pathology

Adelaide Zhao, MD; Benjamin D. Lovin, MD

Department of Otolaryngology – Head and Neck Surgery, University of Virginia, Charlottesville, VA

1. Background

- Spontaneous intracranial hypotension (SIH) is a condition describing low cerebrospinal fluid (CSF) pressure due to spontaneous leakage generally at the level of the spine.[1]
  - SIH is rarely, if ever, caused by a cranial or skull base source, which is what otolaryngologists most often encounter (e.g., anterior and lateral skull base leaks).[2,3]
- The most common presenting symptom of SIH is a positional headache, a symptom that can also present in cranial CSF leaks. Risk factors include an underlying connective tissue disorder.
  - Causes of SIH associated with spinal CSF leaks include spinal nerve root sleeve diverticulum, osteophyte spur, or CSF-venous fistula.[4]
- MRI findings associated with SIH include diffuse pachymeningeal enhancement (in ~80% of SIH patients), subdural fluid collections (in ~50% of patients), venous distension, pituitary hyperemia, and dilation of cerebral sinuses.[1,5,6]
- SIH is often underdiagnosed with an estimated annual incidence of 5 per 100,000.[5]

2. Case Presentation

- 72-year-old male with a history of known right petroclival meningioma presented with new onset positional headache while undergoing radiation. Denied rhinorrhea, otorrhea, or salty/metallic taste.
- CT demonstrated opacified right temporal bone with petrous apex erosion. MRI demonstrated right petroclival meningioma with possible middle ear extension, bilateral subdural hygromas, and T2 hyperintensity in the right temporal bone which did not suppress with FLAIR (Figures 1, 2).
- Diagnostic myringotomy was negative for β2-transferrin. CT cisternogram showed no discrete CSF leak at the skull base. Radionucleotide cisternogram was consistent with CSF leak at the upper thoracic spine, leading to diagnosis of SIH.

Figure 1. MRI on presentation showed large, stable meningioma with infiltration into tympanic cavity and stable tympanomastoid effusion.

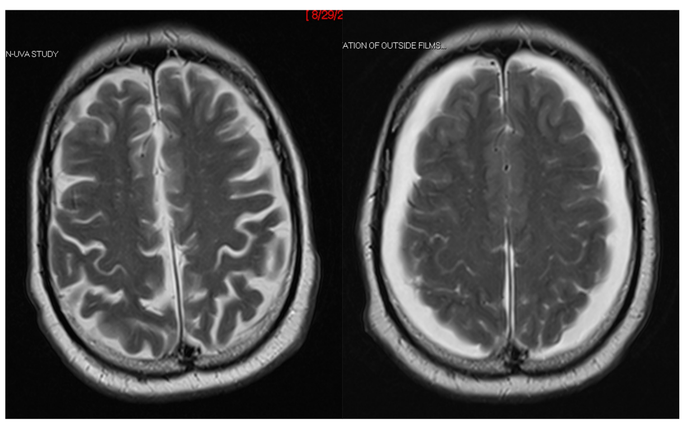

Figure 2. Comparison between old scan from 3 months prior (left) and new scan on presentation (right), which demonstrates interval development of diffuse pachymeningeal thickening and bilateral subdural hygromas.

Contact Information: Benjamin Lovin, MD, blovin@virginia.edu

3. Results

- Patient underwent two epidural blood patches (EBP) for treatment of SIH. He had initial significant clinical improvement after each EBP, but improvement was not durable and symptoms recurred.
- Patient presented to the ED approximately 1 month after his second blood patch with generalized weakness, coordination issues, and progressively worsening headaches. Imaging showed worsened bilateral subdural hygromas now with new blood products concerning for subdural hematomas (Figure 3).
- Patient underwent bilateral subdural drain placements and MMA embolization with Neurosurgery.

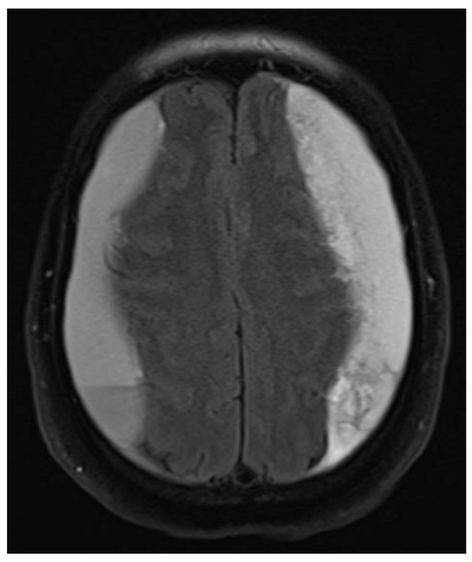

Figure 3. Increased size of bilateral subdural collections, consistent with new acute/subacute blood products

- Given failure of CSF leak control at the level of the spine, suspicion for a second otogenic source despite prior testing, and high risk for further intracranial bleeds, the patient underwent subtotal petrosectomy, ear canal closure, and abdominal fat graft.
  - Intraoperatively, no obvious CSF leak was identified, and the cavity was obliterated with fat. Symptoms improved after surgery and appeared to have resolved at his one month follow up visit.
  - 3-month postoperative imaging showed decrease in size of subdural fluid collections, as well as decreased dural thickening and enhancement (Figure 4).

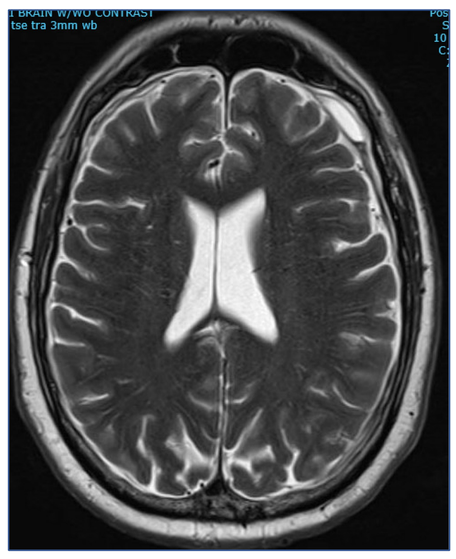

Figure 4. Status post subtotal petrosectomy and fat obliteration there is decreased size of subdural fluid collections and decreased dural thickening/enhancement.

4. Discussion

- Multiple studies have been conducted looking at any association between SIH and skull base CSF leaks. The most prominent study by Schievink et al. examined 273 patients with SIH, none of whom had CSF leak at the skull base.[4]
- Why is low CSF pressure/SIH rarely seen with skull base leaks and instead largely associated with spinal CSF leaks? [3]
  - Spinal CSF leak results in a downward CSF shift from sump effect, causing increased CSF flow in the cervical spine.
  - Cranial CSF leaks maintain physiological CSF flow at the skull base and do not result in downward sump effect, reflecting symptomatology.
- Clear identification of the CSF leak source is critical. Efficacy of different imaging modalities in identifying cranial CSF leaks:
  - CT cisternogram has approximately 85-92% sensitivity in those with active leaks, but only ~40% in those with inactive leaks. [7]
    - High viscosity contrast used may not leak through smaller defect.
  - Radionucleotide cisternogram can be useful in intermittent leaks due to delayed imaging. [8]
    - Significantly lower sensitivity compared to other imaging modalities; should only use if CT or MRI is contraindicated, or as secondary confirmation.[9]
  - Intrathecal gadolinium (Gd)-MRC noted to have highest sensitivity in study comparing diagnostic accuracy of CT, MRI, MRC, Gd-MRC, CT+MRI and RNC.
- β2-transferrin is helpful, but not perfect. Reported sensitivity is ~87-100% with specificities of 71-94%.[8]
- Sources of error with β2-transferrin analysis: [10]
  - Sample-related factors (e.g., carrier materials, sampling error)
  - Patient-related factors (e.g., liver failure, genetic variants of β2-transferrin, drug interactions)
- If a spinal CSF leak and SIH is confirmed, conservative measures and EBP should be first line interventions. Sometimes multiple EBP are necessary for improvement.[5]

5. Conclusion

- Patient's symptoms were likely due to concurrent spinal CSF leak leading to SIH and low-flow temporal leak due to meningioma. Failure for tests to confirm the temporal leak may have been impacted by tumor infiltration.
- This case report is a rare instance of concurrent skull base CSF leak and spinal CSF leak causing SIH.
- There are sample-related and patient-related factors associated with accuracy of β2-transferrin analysis.
- A broad understanding of possible sources of CSF leak, including spinal etiologies, and available diagnostic tests for leak localization are critical to understand for the otolaryngologist. SIH and spinal source is an important consideration in the differential diagnosis in patients with positional headaches and suspected CSF leak.

6. References

1. Schievink W. Spontaneous spinal cerebrospinal fluid leaks. *Cephalalgia*. 2008;28(12):1345-1356. doi:10.1111/j.1468-2982.2008.01776.
2. Schievink WI, Schwartz MS, Maya MM, Moser FG, Rozen TD. Lack of causal association between spontaneous intracranial hypotension and cranial cerebrospinal fluid leaks. *J Neurosurg*. 2012;116(4):749-754. doi:10.3171/2011.12.JNS111474
3. Mark IT, Cutsforth-Gregory J, Luetmer P, et al. Skull Base CSF Leaks: Potential Underlying Pathophysiology and Evaluation of Brain MR Imaging Findings Associated with Spontaneous Intracranial Hypotension. *AJNR Am J Neuroradiol*. 2024;45(10):1593-1596. Published 2024 Oct 3. doi:10.3174/ajnr.A8333
4. Amrhein TJ, Kranz PG. Spontaneous Intracranial Hypotension: Imaging in Diagnosis and Treatment. *Radiol Clin North Am*. 2019;57(2):439-451. doi:10.1016/j.rcl.2018.10.004
5. D'Antona L, Jaime Merchan MA, Vassiliou A, et al. Clinical presentation, investigation findings, and treatment outcomes of spontaneous intracranial hypotension syndrome. *JAMA Neurology*. 2021;78(3):329. doi:10.1001/jamaneurol.2020.4799
6. Jurcau MC, Jurcau A, Hogea VO, Diaconu RG. Spontaneous intracranial hypotension: Case report and update on diagnosis and treatment. *Diagnostics*. 2024;14(9):881. doi:10.3390/diagnostics14090881
7. Hwang SH, Kim SW, Kim DH. Efficacy of Imaging Methods in the Detection and Diagnosis of Cerebrospinal Fluid Rhinorrhea. *Laryngoscope*. 2023;133(6):1281-1287. doi:10.1002/lary.30388
8. Hiremath SB, Gautam AA, Sasindran V, Therakathu J, Benjamin G. Cerebrospinal fluid rhinorrhea and otorrhea: A multimodality imaging approach. *Diagn Interv Imaging*. 2019;100(1):3-15. doi:10.1016/j.diii.2018.05.003
9. Kim DH, Kim SW, Kim SH, et al. Usefulness of imaging studies for diagnosing and localizing cerebrospinal fluid rhinorrhea: A systematic review and meta-analysis. *Int Forum Allergy Rhinol*. 2022; 12: 828–837. https://doi-org.proxy1.library.virginia.edu/10.1002/alr.22932
10. Skedros DG, Cass SP, Hirsch BE, Kelly RH. Sources of error in use of beta-2 transferrin analysis for diagnosing perilymphatic and cerebral spinal fluid leaks. *Otolaryngol Head Neck Surg*. 1993;109(5):861-864. doi:10.1177/019459989310900514
11. Radu RA, Terecoasa EO, Marinescu AN, Enache I, Tiu C. Cranial cerebrospinal fluid leak and intracranial hypotension syndrome - a case report. *J Med Life*. 2021;14(4):587-590. doi:10.25122/jml-2021-0090