# Iatrogenic Anterior Skull Base CSF Leaks Complicated by Central Nervous System Infections and Neurovascular Sequelae: Two Complex Cases Requiring Tailored Endoscopic Repair by Joint ENT and Neurosurgery Collaboration

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## Abstract

Functional Endoscopic Sinus Surgery and skull base surgery have revolutionized the management of sinonasal and anterior skull base pathology. Despite advancements in technique, iatrogenic cerebrospinal fluid (CSF) leaks remain an uncommon but potentially devastating complication, with reported rates of 0.2–0.8%.

Anterior skull base defects, particularly at the cribriform plate and fovea ethmoidalis, leads to a direct communication between the sinonasal tract and intracranial compartment, predisposing patients to meningitis, ventriculitis, pneumocephalus, and neurovascular sequelae. While the Hadad-Bassagasteguy nasoseptal flap has become the gold standard for high flow or extensive leaks, surgical planning becomes more complex when this flap is unavailable or when patients present with systemic complications that preclude immediate intervention.

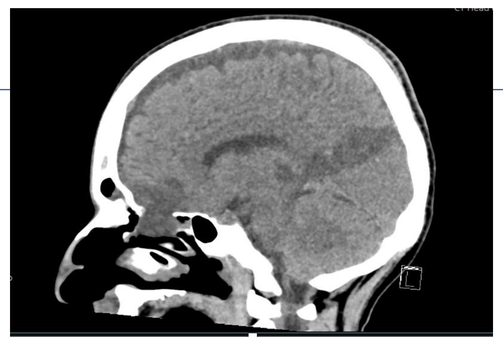
We present two cases of iatrogenic anterior skull base CSF leaks following endoscopic sinonasal surgery performed in outside hospitals, each complicated by distinct CNS sequelae; Streptococcus pneumoniae meningitis with superior sagittal sinus thrombosis and multifocal infarction in one, and ventriculitis with drug-induced hepatitis in the other. Collectively, these cases highlight the critical role of early recognition, multidisciplinary collaboration, and tailored reconstructive strategies when conventional options are not feasible.

## Introduction

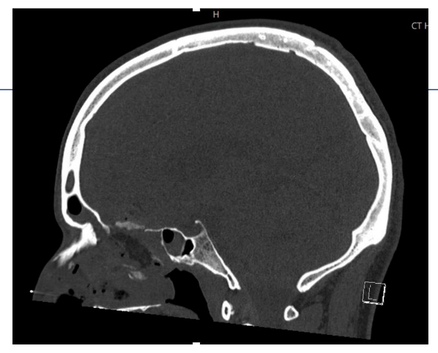
Cerebrospinal fluid (CSF) leak refers to an abnormal communication between the subarachnoid space and the sinonasal (or other extracranial) environment due to a defect in the dura and skull base . This condition can lead to the leakage of CSF into the nasal cavity (CSF rhinorrhea), compromising the protective barrier around the brain and greatly increasing the risk of central nervous system infection such as meningitis . Anterior skull base CSF leaks typically involve defects in the frontal or ethmoidal (cribriform plate) regions, often manifesting as clear, watery nasal drainage. Patients may report a unilateral salty or metallic-tasting rhinorrhea that worsens with maneuvers like bending over or Valsalva, and they can experience orthostatic headaches due to CSF pressure changes. Prompt recognition is critical, as untreated leaks carry up to a 19% per year risk of meningitis

## Case Presentation

Case 1: A 41 year old man who had a functional endoscopic sinus surgery (FESS) in an outside hospital , he underwent bilateral polypectomy, concha bullosa resection, and septoplasty. Within weeks, he developed fever, headache, and altered mental status, progressing to S. pneumoniae meningitis, confirmed on CSF and blood culture panels. MRI demonstrated multifocal ischemic and hemorrhagic infarcts involving both hemispheres and cerebellum, with a short segment superior sagittal sinus thrombosis. CT and MRI revealed a cribriform plate defect with herniated brain tissue into the nasal cavity. He was stabilized with meningitic dose ceftriaxone and corticosteroids. Once infection and inflammatory markers improved, he underwent delayed endoscopic repair. Due to extensive septal loss precluding nasoseptal flap harvest, a multilayer closure was fashioned with fascia lata graft, bone buttress, fibrin glue, and a vascularized inferior turbinate flap. Postoperative imaging confirmed graft integrity, the patient recovered to GCS 15 with mild imbalance requiring rehabilitation, but no recurrent CSF leak.



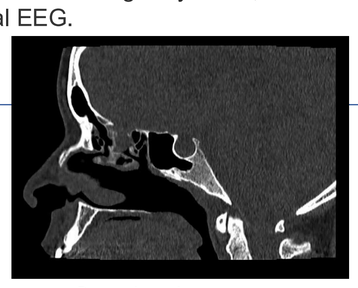
Preop Imaging



Post op Imaging

## Case Presentation

Case 2: A 33 year old woman underwent septoplasty, turbinoplasty, adenoidectomy, and ethmoidectomy at an outside facility. She subsequently developed clear rhinorrhea and was admitted with fever, headache, and vomiting. MRI demonstrated ventriculitis with FLAIR/DWI changes and mild ventriculomegaly. Cultures were negative, but empiric meningitic dose meropenem was initiated. Two brief tonic seizures prompted initiation of levetiracetam. Her clinical status improved, but she developed severe drug-induced hepatitis, necessitating early cessation of meropenem. Subsequent CT and MRI demonstrated a left fovea ethmoidalis cribriform defect with a 16 mm ethmoid meningoencephalocele. She underwent endoscopic endonasal multilayer repair; fascia lata inlay and onlay grafts with autologous fat buttress, fibrin sealant, and repositioned vascularized nasoseptal flap, supported by lumbar drainage. Postoperative imaging showed successful closure. At follow up, she remained neurologically intact, No CSF leak, with normalized liver function and seizure free with a normal EEG.



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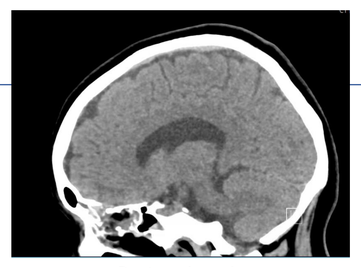

Post op Imaging

## Results

Both patients achieved definitive closure without recurrent CSF rhinorrhea. Case 1 demonstrated recovery from severe CNS infection and venous sinus thrombosis, while Case 2 illustrated resolution of hospital-acquired ventriculitis complicated by antibiotic toxicity. These cases highlight the breadth of systemic and neurological complications arising from anterior skull base CSF leaks, as well as the importance of adaptability in reconstructive technique when the nasoseptal flap is unavailable or non- feasible.

Conclusion: Iatrogenic anterior skull base CSF leaks following sinonasal surgery can manifest with life impeding complications that can extend beyond meningitis, including venous sinus thrombosis, multifocal infarction, ventriculitis, and systemic drug toxicity. Successful management requires prompt recognition, guideline based diagnostics, radiological imaging and ideally, a multidisciplinary approach by ENT and Neurosurgery. Both cases demonstrate that with coordinated care and tailored surgical planning, even the most complex sequelae of iatrogenic skull base CSF leaks can be successfully managed with favorable long term outcomes.

## Discussion

Iatrogenic CSF leaks of the anterior skull base are an infrequent but well-documented complication of endonasal surgery. Reported incidence during FESS and similar sinus procedures ranges from approximately 0.2% up to 0.8% of cases 4 , with experienced surgeons and use of navigation tending toward the lower end of this range. A multi-institutional review of endoscopic sinus surgeries found an average CSF leak rate of <0.5% in modern practice. In revision endoscopic sinus surgery notably have a higher leak risk compared to primary cases, likely due to altered anatomy and scarring obscuring normal landmarks. In our case, the patient's anatomy (possibly a deep olfactory fossa and thin ethmoid roof) was a predisposing factor. A recent study by Vinciguerra et al. (2024) mapping iatrogenic skull base injuries found the cribriform plate and ethmoid roof to be the most commonly involved areas in iatrogenic leaks, in contrast to spontaneous leaks which more often involve the cribriform or sphenoid sinus regions . That study also noted skull base asymmetry can increase the risk, surgeons must be aware that one side's ethmoid roof may be lower than the other, creating a "trap door" effect that can lead to unintentional dural tears.

Notably, about half of iatrogenic leaks are recognized either intraoperatively or immediately post-op, while the other half only manifest days to weeks later . Early-recognized leaks are those where the surgeon sees a dural defect during the procedure or the patient has rhinorrhea in the first 24–48 hours. Delayed presentation (sometimes 1–4 weeks post-surgery) can occur due to wound healing processes. In our case, the leak was evident immediately after the initial surgery, which is fortunate because delayed identification is associated with worse outcomes. A study by Tang et al. (2020) showed that patients in whom iatrogenic leaks were repaired in a delayed fashion had significantly higher rates of meningitis compared to those who received prompt repair (43% vs 0%, P = 0.003.

Before surgical repair, conservative management is instituted to minimize leak and complications. This includes bed rest, head elevation, and avoidance of anything that increases intracranial pressure. Stool softeners are given to prevent straining, and patients are advised to sneeze with an open mouth if needed (to avoid transnasal pressure). If a leak were extremely small and the patient low-risk, one might attempt a short trial of conservative management (48–72 hours) to see if it seals spontaneously, but in practice anterior skull base iatrogenic leaks usually require active repair. In our scenario, given the clear ongoing leak, definitive surgical closure was pursued without delay.

Modern surgical repair of anterior skull base CSF leaks is predominantly performed via a transnasal endoscopic approach, which has become the gold standard for accessible defects in the ethmoid, sphenoid, and frontal recess regions. Endoscopic repair has largely replaced open craniotomy for these lesions due to its high success and low morbidity. The general principle of repair is to reconstruct the skull base defect in multiple layers to reestablish a barrier between the intracranial space and sinonasal cavity.

A critical concept in these repairs is the underlay vs. overlay technique. Often a combined approach is used: for example, fat or fascial graft is placed just underneath the dural opening (underlay) to seal it from above, and then a mucosal flap is laid on top (overlay) to secure it from below . Fibrin glue is commonly applied between layers to act as an adhesive and scaffold for healing . Some surgeons also use bioabsorbable buttress materials (like a piece of collagen matrix or Medpor plate) to support the repair in large skull base defects (often termed a "gasket seal" technique when using a rigid buttress with a wedged piece of fat).

Routine lumbar drainage remains controversial and is now selectively used, as high success rates are achievable without CSF diversion when meticulous multilayer repair, especially with vascularized flap reinforcement is performed. Outcomes for iatrogenic leaks are excellent, recurrence is uncommon in the absence of intracranial hypertension, and timely repair significantly reduces the risk of meningitis and other intracranial complications. Careful preoperative imaging review, precise surgical technique, and prompt intraoperative recognition of dural breaches remain critical for both prevention and optimal management.

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