



Case report And Literature Review of Craniotomy For Frontal Sinus And Ethmoid Bone Fractures With Persistent Cerebrospinal Fluid Fistula Complicated by COVID-19 Infection

Veranis S, Karydakakis P, Argyros A, Burama E, Stamatopoulos C

Neurosurgical Department, 251 General Air Force and Reserve Hospital, Athens, Greece

Correspondence

Veranis Sotiris

251 General Air Force and Reserve Hospital, Kanellopoulou Katehaki 3-5, 11525, Athens, Greece

- Received Date: 25 July 2025
- Accepted Date: 30 July 2025
- Publication Date: 01 Aug 2025

Keywords

Frontal sinus, CSF rhinorrhea, anterior skull base fractures, COVID-19, Neuronavigation

Abbreviations

CSF Cerebrospinal Fluid Leak, MRI Magnetic Resonance Imaging, CT Computed Tomography

Copyright

© 2025 Authors. This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International license.

Abstract

Frontal sinus fractures are a significant cause of morbidity following head injuries. This article presents a case report of a male patient who suffered polytrauma due to a car accident. The patient sustained a comminute frontal bone fracture and anterior skull base fractures, complicated by delayed cerebrospinal fluid (CSF) rhinorrhea. We detail the surgical techniques applied for frontal sinus obliteration and skull base reconstruction and provide a comprehensive review of the literature.

Introduction

Frontal sinus fractures are commonly caused by head trauma, such as car accidents or falls, and can result in various symptoms, including soft tissue swelling, facial deformity, mucocoele, subcutaneous emphysema, pneumocephalus, or, more rarely, tension pneumocephalus [1-5]. In some cases, a frontal sinus fracture can also lead to cerebrospinal fluid (CSF) rhinorrhea, which increases the risk of meningitis [2]. When a frontal sinus fracture is complicated by CSF rhinorrhea, it typically requires surgical repair. The specific details of the procedure depend on the location and extent of the fracture and the amount of CSF leakage. Generally, the goal of surgery is to repair

the fracture, seal the CSF leak and correct deformity.

Purpose

The purpose of this article is to present our institution's surgical protocol for the repair of complicated anterior cranial fossa and frontal sinus fractures and to review the relevant literature.

Materials and Methods

The patient is a 47-year-old Caucasian male who suffered high-energy trauma due to a car accident. He presented to our emergency department with a mild traumatic brain injury, evidenced by a Glasgow Coma Scale (GCS) score of 12/15 (E=3, M=5, V=4), multiple scalp and frontal lacerations, left lower rib fractures,



Figure 1. Brain CT, transverse section depicting initial pneumocephalus

Citation: Veranis S, Karydakakis P, Argyros A, Burama E, Stamatopoulos C. Case report And Literature Review of Craniotomy For Frontal Sinus And Ethmoid Bone Fractures With Persistent Cerebrospinal Fluid Fistula Complicated by COVID-19 Infection. Case Rep Rev. 2025;5(3):68.

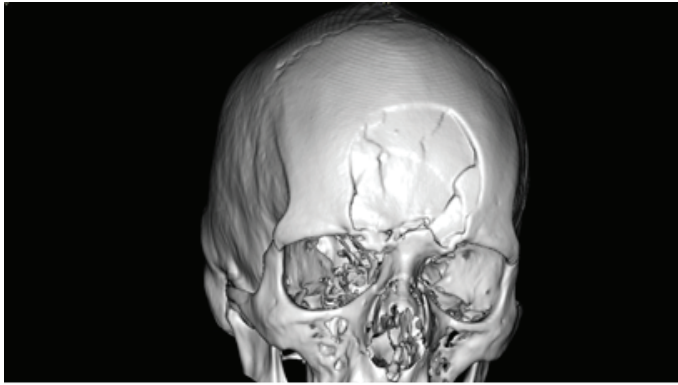


Figure 2. Brain CT scan with 3D reconstruction depicting area of damage and comminute and depressed fracture of the frontal bone

and bilateral lung contusions. An initial brain CT scan revealed a comminute and depressed frontal sinus fracture, ethmoid bone fracture, pneumocephalus, and multiple small (<2 cm) anterior frontal lobe contusions (Figures 1&2). The posterior wall of the frontal sinus exhibited a fracture affecting more than 25% of its area.

Three days later, the patient developed CSF rhinorrhea, necessitating the insertion of a lumbar drain at the L4-5 level. The patient was kept on bed rest for one week and the CSF rhinorrhea ceased. An MRI scan identified the leakage site as a fracture line traversing the posterior ethmoid cells on the left side of the ethmoid bone. Both rhinorrhea and pneumocephalus resolved completely, and the patient was freely mobilized after lumbar drain removal. He was subsequently discharged from the hospital.

At a follow-up visit one month later, the patient's scalp lacerations had healed, but there was forehead deformity due to the depressed frontal bone fracture. Additionally, the patient reported two episodes of CSF rhinorrhea, without headache or fever. A head MRI scan diagnosed a pseudomeningocele filled with CSF protruding through the left posterior ethmoid cells. The patient was scheduled for elective surgery under general anaesthesia.

Surgical Technique and Repair

Patient was intubated and a lumbar drain was put in place in the L4-L5 level. The patient was placed in supine position with head



Figure 3. Intraoperative photograph depicting frontal bone fracture intraoperatively

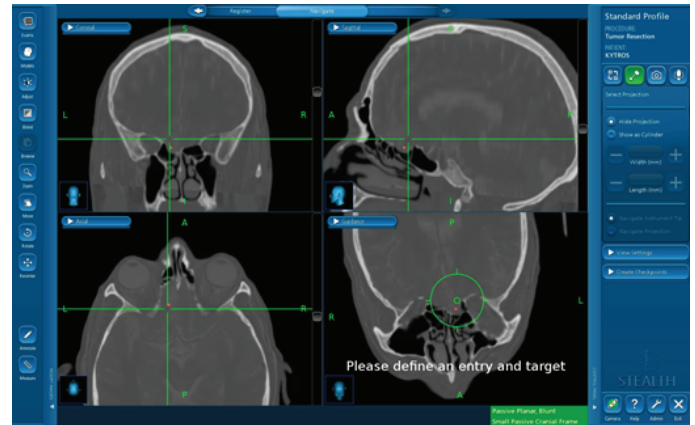


Figure 4. Neuronavigation snap shot of the pointer showing the leaking site

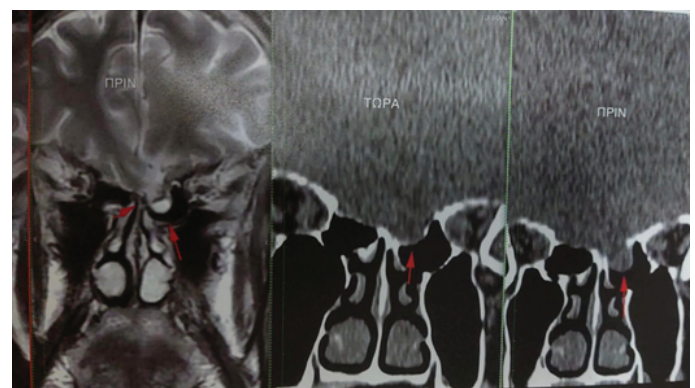


Figure 5. Comparative MRI and CT from left to right, Preoperative coronal MRI T2, meningocele and CSF rinorrhea (red arrows), Coronal CT post op (middle image) and Coronal CT pre-op site of the pseudomeningocele red arrows (right image)

in Mayfield pins. Frameless registration for neuronavigation was completed using Stealth Station 7, Medtronic. Additional surgical site was prepared on the right lower abdominal wall for fat graft preparation and donation. Bicoronal skin incision was utilized. We preserved pericranium. (Figure 3). Frontal craniotomy was performed using two burr holes above anterior sagittal sinus and bone the bone flap was elevated with caution to avoid anterior sagittal sinus tear. The previously comminute fracture of the frontal bone was fused in one large piece and two smaller parts. Depressed fracture of the anterior frontal sinus wall was elevated in three pieces. Frontal sinus mucosa has been removed and a fat graft obliterated completely the frontal sinus duct. Fat graft has been kept in place with Tisseal glue and mobilized pericranium. CSF was removed from lumbar drain before dura opening (40 cm³). Frontal dura incised and by using the neuronavigation probe the site of the CSF leak, through the fracture line, above the posterior ethmoid cells on the left side was recognized and sealed with Tisseal and pericranium. Figure 4. Bone flap secured with titanium miniplates and any defect on the sides was filled with Cranioplasty cement. The rest of the wound was closed in layers. The patient kept supine for and lumbar CSF drain was kept in place for 24 hours postoperatively. No recurrence of rinorrhea was noted and the patient was discharged from the hospital. The aesthetic result was excellent. Postoperative head CT and MRI depicted resolution of the pseudomeningocele, sealing of the CSF leaking site. (Figure 5).

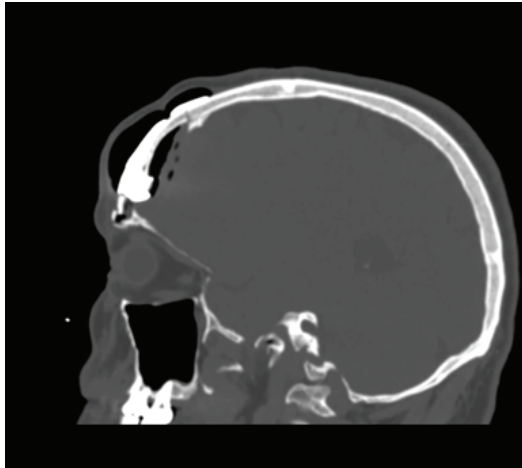


Figure 6. Sagittal reconstruction of brain CT post COVID-19 infection depicting subcutaneous emphysema and pneumocephalus

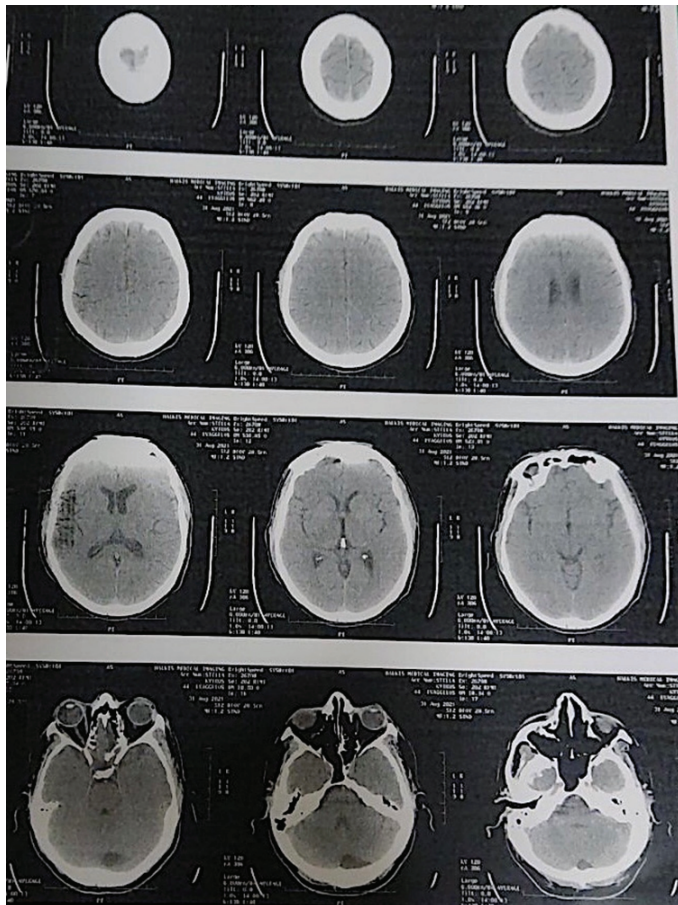


Figure 7. Head CT one month post conservative treatment depicting regression of Pneumocephalus and subcutaneous emphysema

Follow up of the patient

The patient was discharged from the hospital. Unfortunately, ten days later, the patient contracted COVID-19 and developed typical symptoms of upper airway infection, including sneezing and coughing. During recovery, the patient noticed an enlargement in the frontal area under the flap. A CT scan revealed subcutaneous emphysema and pneumocephalus (Figure 6). We treated the patient conservatively with antibiotics (ciprofloxacin 500mg bid for 15 days), high-flow oxygen, and



Figure 8. Final cosmetic result

a head band. He recovered completely and remained stable in follow-up imaging (Figure 7). Final aesthetic result at the last follow up three years later is depicted in Figure 8.

Discussion

This study presents a case involving a comminute, depressed fracture of the frontal and ethmoidal bones with CSF leakage. Our surgical reconstruction technique addressed both the aesthetic deformity and the CSF leak, with the decision to obliterate the frontal sinus. Douglas et al. [6] indicate that sinus repair is warranted when both frontal ducts are intact and there is minimal displacement of the anterior wall without posterior wall fractures or when less than 25% of the posterior frontal sinus wall is fractured. Endoscopic approaches are typically recommended to open the frontal sinus outflow [7]. In our case, the CSF leak and posterior sinus wall fracture necessitated cranialization of the frontal sinus, a procedure supported by Gossman et al. and Bell et al. for complex fractures involving the anterior skull base with CSF leakage [4,8]. Banks et al. [9] advocate for endoscopic repair of posterior wall fractures with CSF leaks, using porcine submucosa xenograft and septal mucoperichondrial autologous graft to reinforce the epidural space. We utilized a pericranial flap to support the anterior skull base sealing, a technique also reported by other authors for anterior skull base and frontal sinus reconstruction [1,3,7,10,11]. In cases of severe trauma to the pericranium, fascia latta, temporalis muscle, or temporalis fascia can be used as free tissue flaps [2]. Occlusion of the frontal sinus, achieved with autologous fat, while Guo et al. [3] suggested the use of gelfoam to eliminate donor site complications. We recommend the use of a neuronavigation probe to identify the leaking site intraoperatively and the topical application of fibrin glue (Tisseal) to secure the leak effectively. The perioperative use of lumbar CSF drainage further reinforces dura repair, a practice favoured by Zhang et al. [2] in their series using the intracranial extradural approach. In our case, we used the intracranial, intradural approach as the leaking site was at

the posterior ethmoid, where dura elevation could cause more damage to the frontal basal dura mater. Contrary to Mayfrank et al. [12], who reported effective inspection of the anterior skull base by temporarily removing the anterior wall of the frontal sinus and elevating the frontal lobe, we found stitching the basal frontal dura at a steep angle technically challenging, with suturing potentially causing small tears. At the conclusion of the operation, the anterior wall of the frontal sinus was secured with titanium miniplates, a method supported by Dumitru et al. [5] and similar to the approach proposed by Doonquah et al. [13]. For comminute anterior skull base fractures, a simple stitching technique, as published by Hoon et al. [14], can be effective. In our case, the two-month interval between the accident and the surgical reconstruction allowed most of the fracture lines at the frontal and ethmoid bones to heal. Radulesco et al [15] published guidelines for performing sinus and anterior skull base surgery during the pandemic. Our patient was operated according to local guidelines and he was tested for COVID-19 before admission. Clinical scenario according to guidelines published by Radulesco were that of urgent surgery because of the CSF leak.

Results

Complicated frontal sinus fractures are common entities related to head trauma. There are various techniques for frontal sinus reconstruction and dura repair in case of CSF leak. According to our experience extensive use of Neuronavigation is a novel technique to reassure sealing of the leaking sites based on preoperative imaging. We have also noticed that COVID-19 infection can potentially affect the healing process from trauma. The infection can lead to complications such as increased inflammation, immune system dysregulation, and overall stress on the body, which can all impact healing. Additionally, the symptoms of COVID-19, such as coughing and sneezing, can put extra strain on frontal sinus cranialization and dura repair, potentially leading to issues like subcutaneous emphysema and pneumocephalus, as seen in our patient's case.

Declarations

Declaration of Conflicting Interest: No Conflict of Interest

Funding: No funding

Ethical approval: Scientific and Ethical Committee of 251 General Air Force and reserve Hospital

Informed Consent: Yes signed by the patient

Trial Registration (where applicable): n/a

Guarantor: VS

Contributorship: PK

Acknowledgements: Nursing staff of the operation theatre

References

1. Ortiz-Galloza E, Chin A, Lane J. Delayed tension pneumocephalus following frontal sinus fracture. *Clin Pract Cases Emerg Med.* 2022;6(1):93-94. doi:10.5811/cpcem.2021.9.53603
2. Zhang F, Wu H, Yin Y, et al. Treatment of traumatic cerebrospinal fluid rhinorrhea via extended extradural anterior skull base approach. *Chin J Traumatol.* 2021;24(5):280-285. doi:10.1016/j.cjtee.2021.06.002
3. Guo Y, Lin S, Liu J, et al. A practical and economical method for frontal sinus reconstruction after frontal craniotomy: a single-center experience with 140 patients. *Front Surg.* 2022;9:919276. doi:10.3389/fsurg.2022.919276
4. Gossman DG, Archer SM, Arosarena OA. Management of frontal sinus fractures: a review of 96 cases. *Laryngoscope.* 2006;116(8):1357-1362. doi:10.1097/01.mlg.0000226009.00145.85
5. Dumitru M, Grigore IR, Toader C, et al. Management of aesthetic and functional deficits in frontal bone trauma. *Medicina (Kaunas).* 2022;58(12):1756. doi:10.3390/medicina58121756
6. Klotch DW. Frontal sinus fractures: anterior skull base. *Facial Plast Surg.* 2000;16(2):127-134. doi:10.1055/s-2000-12574
7. Guy WM, Brissett AE. Contemporary management of traumatic fractures of the frontal sinus. *Otolaryngol Clin North Am.* 2013;46(5):733-748. doi:10.1016/j.otc.2013.07.005
8. Bell RB, Dierks EJ, Brar P, Potter BE. A protocol for the management of frontal sinus fractures emphasizing sinus preservation. *J Oral Maxillofac Surg.* 2007;65(5):825-839. doi:10.1016/j.joms.2006.05.058
9. Banks C, Drakeford C, Strong EB. Frontal sinus fractures and cerebrospinal fluid leaks: a change in surgical paradigm. *Curr Opin Otolaryngol Head Neck Surg.* 2020;28(1):52-60. doi:10.1097/MOO.0000000000000602
10. Archer JB, Riedel CJ, Marks SM, et al. Extensive traumatic anterior skull base fractures with cerebrospinal fluid leak: classification and repair techniques using combined vascularized tissue flaps. *J Neurosurg.* 2016;124(3):647-656. doi:10.3171/2015.4.JNS1528
11. Donath A, Sindwani R. Frontal sinus cranialization using the pericranial flap: an added layer of protection. *Laryngoscope.* 2006;116(9):1585-1588. doi:10.1097/01.mlg.0000232514.31101.39
12. Mayfrank L, Gilsbach JM, Rohde V. Osteoplastic frontal sinusotomy and extradural microsurgical repair of frontobasal cerebrospinal fluid fistulas. *Acta Neurochir (Wien).* 1996;138(3):245-254. doi:10.1007/BF01411734
13. Doonquah L, Brown P, Mullings W. Management of frontal sinus fractures. *Oral Maxillofac Surg Clin North Am.* 2012;24(2):265-274. doi:10.1016/j.coms.2012.01.008
14. Seok H, Im SB, Hwang SC. Reconstruction of anterior skull base fracture using autologous fractured fragments: a simple stitching-up technique. *Korean J Neurotrauma.* 2021;17(1):25. doi:10.13004/kjnt.2021.17.e7
15. Radulesco T, Lechien JR, Sowerby LJ, et al. Sinus and anterior skull base surgery during the COVID-19 pandemic: systematic review, synthesis and YO-IFOS position. *Eur Arch Otorhinolaryngol.* 2021;278:1733-1742. doi:10.1007/s00405-020-06236-9
16. Sahoo NK, Samal M, Agrawal A, et al. Single layer and double layer duraplasty for the management of persistent cerebrospinal fluid rhinorrhea following frontal sinus trauma: a retrospective study. *J Craniofac Surg.* Published online 2021. doi:10.1097/SCS.00000000000007454.