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Case Report

Operative treatment and postoperative complications of a frontal sinus fracture: a case report

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ABSTRACT

Frontal sinus fractures are significant injuries; they represent approximately 5-15% of all maxillofacial trauma cases. These fractures can cause complications and present important challenges. The type of surgical technique used, such as sinus reconstruction or obliteration, depends on the severity of the trauma and the general condition of the patient. The surgical treatment for frontal sinus fractures may include a coronal approach. The outcomes associated with frontal sinus fractures can range from mild headaches to severe complications, including cerebrospinal fluid (CSF) leakage; in cases of ineffective conservative treatment, surgical intervention may be necessary. TachoSil is used as a sealing agent during surgery to mitigate potential complications.

Keywords: Frontal sinus fracture, TachoSil, CSF leakage

INTRODUCTION

Frontal bone fractures involving the frontal sinus represent 5-15% of all maxillofacial injuries but can have serious consequences if they are not treated properly. While no universal guidelines exist, complications can be classified as acute (less than six weeks) or chronic (more than six weeks). These fractures pose surgical challenges and are susceptible to infections due to microbiological flora of the area and its connection to the nasal cavity, potentially leading to life-threatening conditions. In addition, frontal bone fractures can cause aesthetic defects, including deformities and irregularities.[1,2]

Epidemiology

Falls, assaults, and traffic accidents mainly cause head injuries in adults. Frontal bone fractures can coexist with other skull fractures, leading to complications such as CSF leakage ruptures of the meningeal vessels and nerves, which can result in disability or death.[2-5] Schütz et al reported that 44% of frontal injuries are due to traffic accidents, 27% are due to falls, 12% are due to impacts, 6% are due to assaults, and 11% are the result of other causes.[5] In women, 70% of injuries result from falls, often related to domestic violence or suicide attempts. In their retrospective study, Mahran et al found that road traffic accidents accounted for 49% of frontal sinus fractures, with isolated fractures as the most common (47.2%) and posterior table fractures as the least frequent (16%). Conservative treatment was used in 37.1% of the cases, while 62.8% of the patient's required surgery.[2]

Diagnostics

Frontal bone fractures often present with tenderness, paraesthesia, abrasions, bruising, contour irregularities, and hematoma. Sterile examination of forehead bruising is recommended, followed by radiological imaging. Patients should be asked about nasal fluid discharge, which could indicate CSF leakage, confirmed by the 'halo test' or glucose/β2-transferrin tests. Computed

tomography (CT) is the gold standard for assessing these fractures, because simple X-rays are insufficient.[5]

Surgical treatment

Frontal sinus injuries are associated with significant morbidity, often necessitating surgical intervention. The coronal approach is used most commonly because the incision minimises facial scarring and provides broad access to the frontal bone. Important considerations include male pattern baldness, cranial growth in children, and preservation of the facial nerve to avoid paralysis.[5] Frontal sinus management includes reconstruction in which anterior wall fragments are restored or removed and reconstructed with microplates or titanium mesh. Sinus obliteration involves removing the mucosa and filling the cavity with materials to prevent infections. Endoscopic techniques provide a less invasive option for reconstruction or obliteration, promoting faster recovery. In severe cases, exenteration of the frontal sinus removes the posterior sinus wall to create space for brain expansion, which can lead to spontaneous ossification.[5]

Complications

Frontal sinus fractures can cause early and delayed complications in 10-17% of cases, including life-threatening infections, particularly if intracranial infections occur. Delaying treatment by more than 48 hours significantly increases risk of infection. However, due to other severe injuries or intracranial damage, treatment is often delayed until the patient stabilises. Historically, 7-day wait has been recommended before treating CSF leaks, but recent studies question this approach. There is a lack of strong evidence for the use of antibacterial prophylaxis after frontal sinus or skull base fractures, and there is no standard protocol. Although some surgeons continue to prescribe antibiotics, their overuse can promote bacterial resistance. Postoperative complications can include thrombosis, encephalitis, mucoceles, brain abscesses, sinusitis, CSF leaks, deformities, infections, and chronic pain.[5]

The duration of monitoring in patients with frontal sinus fractures is debated. Some recommend lifelong follow-up due to potential long-term complications, while others suggest 5-7 years. In a 5-year study, 20% of patients had chronic headaches, 13.2% developed pneumocephalus, and 8.5% experienced CSF leaks, some of which required surgery. Meningitis occurred in 0.7% of patients-it was treated with intravenous antibiotics-and 7.4% of patients had visual disturbances, including cases of blindness. Frontal mucoceles were seen in 1.9% of patients and were mostly treated endoscopically, while 1.1% of patient's developed osteomyelitis, with one fatality.[2,5]

CSF leakage

Spontaneous CSF rhinorrhoea is often associated with anomalies in the skull and sinuses, and it can also occur due to skull trauma leading to dura mater tears. The diagnosis of CSF rhinorrhoea is primarily based on radiological examinations, including sinus CT, CT cisternography, and magnetic resonance imaging (MRI). CT is effective in accurately localising bone defects, while CT cisternography offers greater precision in revealing the morphology and size of the leak.[6]

Patients who do not recover after 3-4 weeks of conservative treatment should undergo surgical repair. Surgical approaches include tissue grafting and defect repair, with the choice of technique influenced by the location of the defect and the general condition of the patient. Many experts consider the endoscopic approach to be an excellent option for repairing CSF leaks, as it reduces the incidence of complications. Currently, the most widely used approaches include the anterior cranial fossa epidural approach and the nasal endoscopic extracranial approach. The current standard repair technique is known as the 'overlay and underlay' method. This often involves the use of epidural endoscopy to insert the graft material between the bone and the dura mater. According to Tilak et al acetazolamide is an effective primary therapy for spontaneous CSF rhinorrhoea, potentially avoiding surgery in 31.3% of cases and serving as the primary treatment for isolated spontaneous leaks when there are no contraindications.[6-8]

The reconstructive role of TachoSil

Postoperative CSF leakage remains one of the most serious and life-threatening complications in neurosurgery. Persistent CSF leakage is associated with prolonged hospitalisation, poorer neurological outcomes, and the development of CSF fistulas. Graziano et al studied complications when TachoSil-an equine collagen sponge coated with fibrinogen and thrombin isolated from human plasma-was used. Haemorrhage, CSF fistulas, and infections were among the most challenging postoperative complications in neurosurgery. Fibrin sealants have been developed to ensure effective haemostasis, airtight seal and secure closure of defects.[9,10]

CASE REPORT

A 61-year-old male sustained a fall on the pavement, striking his head against a stone and briefly losing consciousness. Although he had consumed alcohol throughout the day, he retained full recollection of the events. He was admitted to Pauls Stradins Clinical University Hospital with the assistance of emergency medical services. Upon examination, the patient was conscious; haemodynamically stable; oriented to time and place; and had normal skin colour, respiration, and pulse. Both pupils were dilated, and the Glasgow Coma Scale (GCS) score was 15/15. The clinical assessment identified a laceration and bone impression on the forehead. The patient's medical history revealed no regular medication use and only pulmonary arterial hypertension as a chronic condition. He reported no

known drug allergies. In the admission department, haemostasis was achieved, and an 8-cm laceration on the forehead was closed under local anaesthesia using Novosyn 3/0 for deeper layers and Dafilon 4/0 for the skin. A head CT scan was subsequently performed, and the patient received a DtAdult vaccination.

Preoperative CT results and therapy

Two preop CT scans were performed. First, conducted on day of admission, revealed thin bilateral subdural hematomas along anterior frontal lobes, bilateral subarachnoid haemorrhage in anterior basal frontal lobes, pneumocephalus, comminuted multifragmentary depressed fracture of frontal bone, a nasal bone fracture, and a displaced fracture of upper lateral wall of left orbit.

The treatment plan included administration of various medications to manage infection, to reduce swelling, to relieve pain, and to avoid specific complications. Key approaches included antibiotics, osmotic agents, anti-inflammatory drugs, and anticonvulsants as part of overall therapeutic strategy. A surgical intervention was deferred for three days to facilitate reduction of haematoma and oedema.

Figure 1 (A and B): Preoperative CT scan of the head on third-day post-trauma.

The second CT scan was conducted on the third-day post-trauma (Figure 1 A and B). The findings indicated a significant reduction of post-traumatic subarachnoid haemorrhage, which was nearly undetectable in the frontal lobes, as well as a decreased volume of subdural blood collection. Notably, the volume of intracranial air had also diminished. Additionally, the scan revealed multiple subacute facial bone fractures with displacement and deformation, comminuted fractures exhibiting slight depression of the frontal sinus plates, and displaced fractures of the left orbital walls. Fractures of the nasal septum, nasal bone, and right maxillary sinus were also identified, accompanied by a haemorrhagic component in the frontal sinuses and separate ethmoidal cells.

Surgical procedure

Surgery was conducted in collaboration with oral and maxillofacial surgeons and neurosurgeons on the fourth day post-trauma. The coronal approach was used. Upon visualisation of the frontal bone fracture, unstable bone fragments were evacuated. The neurosurgeons performed a wound revision on the inner wall of the frontal sinus and repaired the dura mater defect using TachoSil. Stable bone fragments were fixed with 1.5-mm microplates, and the remaining defect was closed with titanium mesh secured by 0.6-mm microscrews. The wound was subsequently closed primarily layer by layer, and two active drains were placed. Operation proceeded without complications, and a secure aseptic dressing was applied.

Results of the treatment

Postoperatively, the patient reported headaches accompanied by a brownish, watery nasal discharge, which manifested on the third day following the procedure. The nasal fluid was sent to the laboratory for analysis, revealing 70-80 leukocytes per field of view, along with erythrocytes that covered the entire field. The presence of CSF could not be determined due to technical limitations. At that time, the therapeutic regimen included antibiotics (ceftriaxone 1 g intravenously twice daily and metronidazole 500 mg intravenously three times daily), analgesics (metamizole 50 mg intravenously twice daily), and an anticonvulsant (carbamazepine 200 mg orally twice daily). A CT scan performed on the fifth day after operative treatment (Figures 2 and 3). It showed the absence of subarachnoid and brain haemorrhage, successful frontal bone osteosynthesis, and the presence of haemorrhagic content in the frontal sinuses.

The patient was discharged ten days after hospitalisation (six days after the surgical procedure) and continued antibacterial therapy for ten days at home. At the time of discharge, the patient reported feeling well, his headaches were well controlled by medication, and his nasal discharge had resolved within three days. A follow-up visit was scheduled for two weeks later. During this visit, the wound had healed well, the neurological examination

did not show abnormalities, and there were no reported headaches or nasal discharge.

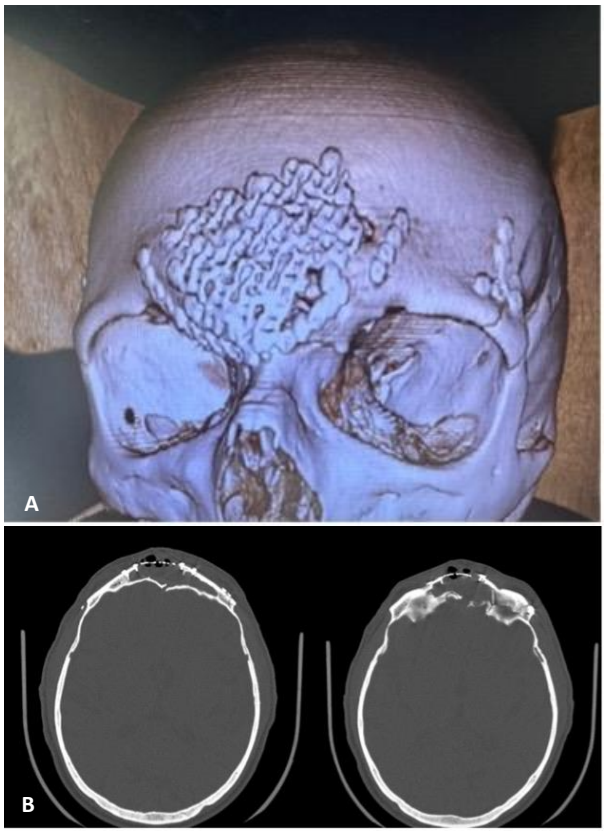

Figure 2 (A and B): Postoperative CT scan of the head on fifth day after operative treatment.

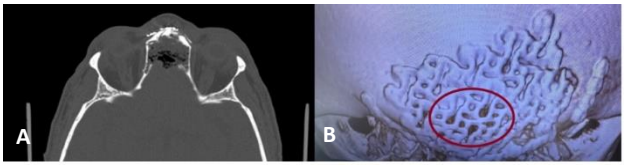

Figure 3 (A and B): Postoperative CT scan of the head, free air.

DISCUSSION

In their retrospective review Mahran et al found that road traffic accidents accounted for the majority of frontal sinus fractures (49% of cases).[2] Additionally, they reported that impacts from falls from heights (17%) also make a substantial contribution to these injuries; our patient sustained his injuries from this factor having fallen onto the pavement and striking his head against a stone. Our patient's surgical intervention involved a coronal incision, which Schütz et al identified as a standard approach for frontal sinus fractures aimed at minimising visible facial scarring.[5] Consistent with the findings reported by Hung et al our patient was treated with titanium microplates and mesh to stabilise the bone fragments and with TachoSil to seal the dura mater defect.[3] Graziano et al reported five cases in which TachoSil was used to restore the ventricular wall and to close bone defects.[9] This approach, along with postoperative care based on the local protocols, led to successful outcomes, with no complications such as hematoma, CSF accumulation, CSF rhinorrhoea, and allergic reactions.

Schütz et al highlighted the elevated risk of postoperative complications associated with frontal sinus fractures, which may include thrombosis, encephalitis, mucoceles, brain abscesses, sinusitis, deformities, infections, chronic pain, and CSF leakage.[5] In our case, the patient appeared to experience a CSF leak characterized by an atypical brown shade, potentially a hemorrhagic origin as supported by the presence of leukocytes and erythrocytes identified in laboratory analyses, possibly due to a subarachnoid hematoma. Graziano et al suggested that TachoSil may be effective in preventing CSF leaks, but it did not entirely mitigate postoperative leakage in our patient.[9] This finding is consistent with the findings reported by George et al.[11] Those authors compared the efficacy and safety of TachoSil as an adjunctive measure in patients undergoing skull base surgery with dura mater closure. Although TachoSil resulted in a lower CSF leak rate (6.9% vs 8.2%), this difference was not statistically significant. Importantly, both treatments were well tolerated, with a similar incidence of adverse events, indicating that TachoSil is safe and potentially effective in reducing CSF leaks despite not meeting the primary endpoint. It is noteworthy that in our patient, the leak colour was atypical, and the laboratory tests indicated only elevated leukocytes and erythrocytes. Thus, there was no definitive confirmation that our patient developed a CSF leak.

The postoperative management of the CSF leak in our case adhered to established protocols in the literature, with the patient receiving antibiotics to mitigate the infection risk. While the necessity of antibiotic prophylaxis remains a topic of debate, as noted by Galli et al antibiotic therapy was beneficial for our patient. The CSF leak emerged on the third postoperative day and was resolved within three days.[8] Given the patient's improvement with conservative treatment, no further surgical intervention was required, and no additional complications related to CSF leakage were reported. Nonetheless, Tilak et al identified acetazolamide as an effective primary intervention for spontaneous CSF rhinorrhoea, which we did not employ for our patient.[7]

Galli et al described a conservative approach to manage CSF leaks, particularly in cases involving linear fractures of the facial bones.[8] They emphasised the importance of patient education regarding head elevation and the limitation of physical activities as well as the necessity of avoiding over-drainage to prevent further complications. Indications for delayed surgical intervention include persistent CSF leakage after ten days of conservative treatment, recurrence of leakage, and complications such as meningitis or abscess formation. Meningitis occurs in

approximately 19% of cases with persistent CSF leakage, carrying a mortality rate of 10%. According to Oh et al the most common pathogens associated with meningitis in cases of persistent CSF leakage are *S. pneumoniae* and *H. influenzae*.[12] The use of prophylactic antibiotics for preventing meningitis remains a subject of ongoing debate. However, when antibiotics are administered, ceftriaxone and ampicillin/sulfadiazine are commonly used. In our case, ceftriaxone was also employed for postoperative prophylaxis, in combination with metronidazole, as part of the treatment regimen.

CONCLUSION

Even when TachoSil is used to mitigate postoperative complications, CSF leakage remains a potential risk. This highlights the fact that although adjunctive measures may improve surgical outcomes, they do not eliminate complications.

The CSF leak characterized by an atypical brown colour in our patient was resolved within three days with the use of antibiotics. This underscores the need for ongoing vigilance in postoperative management and suggests that the implementation of antibacterial therapy may be beneficial in addressing this complication and preventing secondary infections.

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REFERENCES

1. Jeyaraj P. Frontal bone fractures and frontal sinus injuries: treatment paradigms. Ann Maxillofac Surg. 2019;9(2):261-82.
2. Mahran H, Elshamaa M, Abdelfattah M, Mohammed M, Abdelhamid A, Elborolsy S. Epidemiology and outcome of management of frontal sinus fractures. Egypt Dent J. 2023;69(1):111-7.
3. Hung CC, Chiu WT, Lee LS, Lin LS, Shih CJ. Risk factors predicting surgically significant intracranial hematomas in patients with head injuries. J Formos Med Assoc. 1996;95(4):294-7.
4. Fabbri A, Servadei F, Marchesini G, Stein SC, Vandelli A. Early predictors of unfavorable outcome in subjects with moderate head injury in the emergency department. J Neurol Neurosurg Psychiat. 2008;79(5):567-73.
5. Schütz P, Ibrahim HHH, Rajab B. Contemporary Management of Frontal Sinus Injuries and Frontal Bone Fractures. In: A Textbook of Advanced Oral and Maxillofacial Surgery. 2015;2.
6. Chen GY, Ma L, Xu ML, Zhang JN, He ZD, He CY, et al. Spontaneous cerebrospinal fluid rhinorrhea: A case report and analysis. Medicine (Baltimore). 2018;97(5):e9758.
7. Tilak AM, Koehn H, Mattos J, Payne SC. Preoperative management of spontaneous cerebrospinal fluid rhinorrhea with acetazolamide. Int Forum Allergy Rhinol. 2019;9(3):265-9.
8. Galli J, Morelli F, Rigante M, Paludetti G. Management of cerebrospinal fluid leak: the importance of multidisciplinary approach. Acta Otorhinolaryngol Ital. 2021;41(1):S18-29.
9. Graziano F, Maugeri R, Luigi B, Guli C, Iacopino D.G. The reconstructive role of TachoSil in neurosurgery. Interdiscip Neurosurg. 2016;6:51-4.
10. European Medicines Agency (EMA). TachoSil product information. Available at: https://www.ema.europa.eu/en/documents/product-information/tachosil-epar-product-information_en.pdf. Accessed on 09 September 2024.
11. George B, Matula C, Kihlström L, Ferrer E, Tetens V. Safety and Efficacy of TachoSil (Absorbable Fibrin Sealant Patch) Compared with Current Practice for the Prevention of Cerebrospinal Fluid Leaks in Patients Undergoing Skull Base Surgery: A Randomized Controlled Trial. Neurosurgery. 2017;80(6):847-53.
12. Oh JW, Kim SH, Whang K. Traumatic Cerebrospinal Fluid Leak: Diagnosis and Management. Korean J Neurotrauma. 2017;13(2):63-7.

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