

Case Report

Multi-layer approach to complex traumatic anterior skull base fracture repair: A case report

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ABSTRACT

Background: Anterior skull base fractures represent a unique challenge for neurosurgical repair due to the potential for orbital injury and the proximity to the air sinuses, yielding increased possibility for infection, and persistent cerebrospinal fluid (CSF) leak. While multiple techniques are available for the repair of anterior skull base defects, there exists a paucity of robust, long-term clinical data to guide the optimal surgical management of these fractures.

Case Description: We present the case of a complex, traumatic penetrating anterior skull base fracture, and describe a multi-layered approach for successful repair – namely, with the use of a temporally-based pericranial flap, split-thickness frontal bone graft, and autogenous abdominal fat graft. The patient was followed for nine months postoperatively, over which time she experienced no significant complications.

Conclusion: The goal of successful anterior skull base repair involves creating a durable, watertight separation between intra and extracranial compartments to prevent CSF leak, protect intracranial structures, and minimize infection risk. The temporally-based pericranial flap, split-thickness frontal bone graft, and autogenous abdominal fat graft represent safe and efficacious approaches to achieve lasting repair.

Keywords: Anterior skull base, Cranial trauma, Pericranial flap, Skull base fracture, Skull base repair

INTRODUCTION

While basal skull fractures are a common complication of severe head trauma, complex anterior skull base fractures – involving the frontal, ethmoid, or sphenoid bones – present special considerations due to the potential for orbital injury and as well as infection and cerebrospinal fluid (CSF) leak secondary to the proximity of the air sinuses.^[5] However, few robust systematic studies regarding their optimal management exist, and there remains significant controversy surrounding the appropriate surgical management of these fractures.^[2] Here, we present the case of a complex, traumatic penetrating anterior skull base fracture and highlight techniques used to achieve a successful, lasting repair.

CASE PRESENTATION

The patient is an 87-year-old female who presented after falling on a reclining chair lever, resulting in penetrating trauma to the left face [Figure 1]. On arrival, the patient was alert and oriented,

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with a Glasgow Coma Scale of 14. No seizures occurred during transit to the hospital. She was found to have full strength and sensation in all four extremities. The right pupil was reactive. Clear rhinorrhea was observed, and pulsatile bleeding from the affected orbit was noted. Head computed tomography (CT) revealed the lever had speared through the left globe, fracturing the left frontal, maxillary, and ethmoid sinuses as well as the inferior, medial, and superior orbital walls. It further extended into the intracranial space resulting in bifrontal contusion and intraparenchymal hemorrhage [Figure 2]. Given the severity of the trauma and violation of intracranial structures, the patient was taken to the operating room by the neurosurgical team for urgent foreign body removal and anterior skull base repair in conjunction with the otorhinolaryngology and ophthalmology teams.

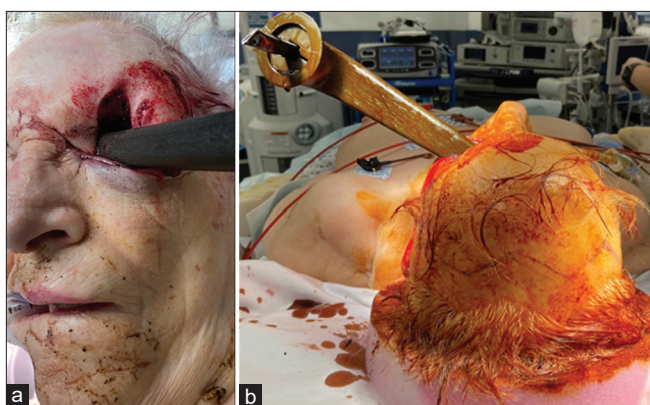


Figure 1: Preoperative photographs of the patient's facial trauma secondary to impalement by a reclining chair lever, both on arrival to the emergency room (a) and in the operating room (b).

Preoperatively, the patient was administered vancomycin, ceftriaxone, and levetiracetam for meningitis and seizure prophylaxis. Pain was controlled with IV fentanyl, and the patient remained within her systolic blood pressure goal of below 160. After induction of general anesthesia, the patient was placed supine and a bicoronal incision was made. The scalp was raised in a subgaleal plane and the temporoparietal fascia was used to raise a temporally-based pericranial flap. A bifrontal craniotomy was then performed and the foreign body was removed. After thorough irrigation, delicate hemostasis of the frontal lobe was achieved. Surgicel was placed over any areas of contusion or tissue disruption concerning for future bleeding. The left orbital rim was fractured, exposing the frontal sinus and mucosa underneath with a large anterior skull base defect noted at the orbital roof. The frontal sinuses were cranialized, and the mucosa was meticulously removed from the sinus wall. The pericranial flap was mobilized, rotated laterally, and laid over the large defect on the floor of the anterior skull base. Interrupted sutures were used to secure the flap to the dura. A split-thickness bone graft was harvested from the inner table of the frontal bone, placed on top of the defect, and secured with screws. Surgical and a gelatin-human thrombin matrix (FloSeal) were used to aid in hemostasis; DuraGen was then applied for a multi-layered closure over the defect repair.

Given the extensive globe damage, the left eye evisceration was performed. Following this, autogenous abdominal fat previously harvested by the neurosurgical team was used to fill the space within the bilateral cranialized frontal sinuses. The craniotomy bone flap was then replaced.

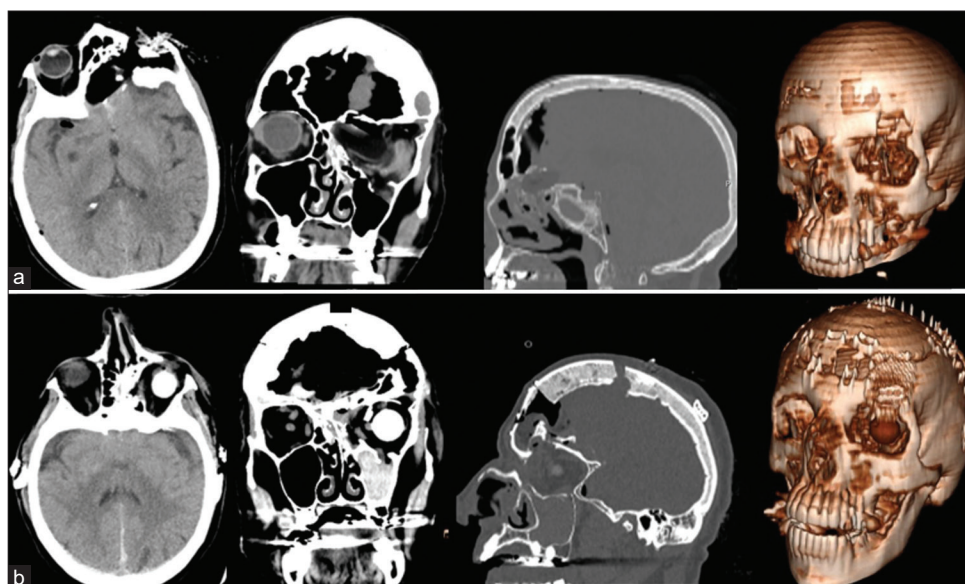


Figure 2: Preoperative (a) and postoperative (b) axial, coronal, and sagittal computed tomography images of the repair site. The far-right images represent 3D reconstructions of the skull trauma and subsequent repair.

Postoperatively, the patient was admitted to the neurological intensive care unit and continued on a 7-day course of vancomycin and ceftriaxone for meningitis prophylaxis. Postoperative magnetic resonance imaging and CT scans showed expected postsurgical changes. She was stable for discharge to a rehabilitation center after a hospital stay of 16 days. She was discharged from rehabilitation after 3 weeks. Over a 9-month follow-up period, there was no report of CSF leak or intracranial infection.

DISCUSSION

We present a case of an extensively complex anterior skull base fracture repair. The goal of skull base repair is to obtain a structurally secure, water-tight separation between intra and extracranial compartments to protect intracranial structures, prevent herniation, and minimize risk of infection or CSF leak.^[1,5] To achieve these objectives, this case demonstrates multi-layered techniques for successful repair of a traumatic anterior skull base defect, including the use of a temporally-based pericranial flap, split-thickness frontal bone graft, and autogenous abdominal fat graft.

Lateral versus anterior pericranial flap

The pericranium is a scalp layer composed of the periosteum and overlying loose areolar connective tissue.^[5] If the scalp is dissected in a subgaleal plane, the pericranium can be harvested from the skull into a flap, which can then be mobilized toward the craniotomy site and draped to line the skull defect and wall of the cranialized frontal sinus. The use of a pericranial flap in anterior skull base repair helps ensure a watertight partition between intra and extracranial compartments after frontal sinus cranialization and defect repair.^[5] This approach augments protection of the intracranial contents with well-vascularized tissue, which encourages healing and achieves the critical goal of preventing persistent CSF leak through the defect.^[5] The pericranial flap can be taken from the anterior or lateral scalp. Anterior flaps, while well-known and easily harvestable, have been associated with high rates of persistent postoperative CSF leak, up to 17%.^[5] A temporally-based pericranial flap, as was used in this patient, represents an alternative option taken from the lateral scalp. This flap often involves the temporalis fascia inferiorly, yielding an extremely well-vascularized flap that receives blood supply from the superficial and deep temporal arteries.^[5] In a patient with significant anterior skull trauma, these vessels are less likely to be disrupted than the supraorbital and supratrochlear vessels which would supply an anterior flap;^[5] thus, the temporally-based pericranial flap may be a more favorable option. Alternatives to the use of a pericranial flap include free external grafts made from synthetic or biologic material. However, these materials are often a suboptimal choice as they have a significantly higher

failure rate than well-vascularized pericranial flaps, especially when used for larger defects.^[5]

Bone closure

The use of a split-thickness frontal bone graft was also demonstrated in this anterior skull base repair. In patients with complex defects, a cranial bone graft allows for structural repair to prevent brain herniation or migration of a pericranial flap, if used.^[1,5] Many options for graft material exist, including alloplastic materials or autogenous bone from various donor sites. While alloplastic materials are easily manipulatable and offer no size restrictions, they are associated with higher rates of infection and inflammation.^[1] Using autogenous cranial bone is specifically advantageous as it can be accessed from the primary surgical field and is associated with very little postoperative resorption.^[1] Thus, split-thickness cranial bone grafts represent a safe and effective option to augment anterior skull base defect repair. Disadvantages include the difficulty associated with splitting the cranial bones between the inner and outer tables. Although it can be easy for the inexperienced surgeon to fracture the bone while attempting to split it, screws can be used to reconstruct the bone into a satisfactory graft for use.^[1]

Fat graft

For the present case, we opted to use an autogenous abdominal fat graft to fill the cranialized frontal sinuses to aid in closure of dead space. Grafted abdominal fat is easily available and has been shown to encourage healing and prevent regrowth of mucoperiosteum.^[3,4] While the use of abdominal fat grafts is a standard practice for sinus obliteration when the posterior wall of the frontal sinus remains intact,^[3] fewer reports have investigated its use in the context of frontal sinus cranialization as demonstrated here. Risks associated with grafting abdominal fat to the frontal sinuses include infection as well as mucocele formation in the setting of graft resorption,^[2,3] though the incidence of these complications is reportedly low, even in long-term follow-up.^[3,4]

CONCLUSION

When choosing the appropriate surgical approach to repair complex anterior skull base defects, paramount considerations include creating a watertight separation between intra and extracranial compartments to prevent infection and CSF leak, while maintaining protection of intracranial structures. Use of a pericranial flap, split-thickness cranial bone graft, and abdominal fat graft represent feasible and effective techniques to achieve these goals during defect repair.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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