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Massive Craniocerebral Wound Reconstruction Using Fascia Lata Graft: A Case Report and Technical Note

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Abstract

Penetrating head injury is rare and, their management is nonstandard with persistent cerebrospinal fluid (CSF) leakage being possibly challenging to treat. A 34-year-old man with no past medical history was referred in emergency room for an impressive accidental penetrating craniocerebral wound through which the brain was extruding due to the raised intracranial pressure. Computed tomography scan showed a comminuted frontal fracture extended to the anterior skull base and a severe bifrontal lobe concussion with a diffuse intracranial hemorrhage. A debridement and washout of the craniocerebral wound were achieved with careful hemostasis followed by a decompressive craniectomy. Fortunately, the patient survived but, the CSF continued to leak through the anterior skull base fracture with no endoscopic treatment possibility. Fifteen days after the initial trauma, a surgical sealing was decided using a large fascia lata sheath harvested on the right thigh by a "S"-shaped incision. A significant piece of fascia lata was cut off and meticulously sutured to the remaining dura mater rims in double-layered watertight fashion. Both cranial and right thigh wounds healed uneventfully and the CSF leak never reoccurred. Twenty-two weeks after the initial trauma, a custom-made titanium cranioplasty was inserted without any dissection difficulty. In case of persistent CSF leakage not amenable to endonasal endoscopic treatment, the use of a large piece of facia lata harvested on the thigh using an "S"-shaped incision is a simple, reliable way to efficiently repair a large dura mater defect. It requires neither special skills nor sophisticated instruments.

Keywords
- traumatic brain injury
- penetrating brain injury
- CSF leakage
- facia lata
- reconstruction

Introduction

Traumatic brain injury (TBI) is one of the leading causes of death and disability with an approximated incidence of 64 to 74 million persons per year.[1] TBI is traditionally identified as mild, moderate, or severe by the Glasgow Coma Scale (GCS) at presentation.[2] About 5.5 million people are estimated to suffer from severe traumatic brain injury each year (73 cases per 100,000 people), especially in the least developed countries.[3] Penetrating brain injury (PBI) is a relatively uncommon form of TBI but, the most lethal; its main cause are gunshots.[4,5]

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Case Report and Technical Note

At work, a 34-year-old man was repairing an escalator when a metal cylinder accidentally bounced out and struck his forehead. He was rescued by a mobile medical unit: initial GCS 14 dropped at 8 requiring medical resuscitation and a transfusion to treat a hemorrhagic shock once arrived at the hospital. Computed tomography scan showed a comminuted frontal fracture extended to the anterior skull base and a severe bifrontal lobe concussion with a diffuse intracranial hemorrhage (Fig. 1A,B).

In the operative theater, removal of the head bandage exposed a massive bleeding craniocerebral wound through which the brain was extruding due to the raised intracranial pressure (►**Fig. 1C**). Head pined in a Mayfield skull clamp, the frontal scalp was released via a bicoronal incision and retracted downward until to exposed both supraorbital ridges. A decompressive bifrontal bone flap surrounding the burst fracture was cut off. Intra- and extradural exploration retrieved numerous bone debris mixed with mashed cerebral parenchyma. A debridement and washout of the craniocerebral wound was achieved with careful hemostasis (►**Fig. 1D**). An external ventricular drain was inserted and the remains of the frontal epicranial aponeurosis were sutured to the dura mater before closure of the scalp (►**Fig. 1E**). Fortunately, the patient survived but cerebrospinal fluid (CSF) continued to leak through the anterior skull base fracture in the nasal cavity with no endoscopic treatment possibility. Fifteen days after the initial trauma, a surgical sealing was decided using a large fascia lata sheath.

To get a proper exposure, a "S"-shaped incision on the right thigh was used in these second surgery (►**Fig. 2A–D**). A significant piece of fascia lata was cut off exposing the vastus lateralis muscle underneath (►**Fig. 2E, F**). After redo bicoronal incision and surgical exposition and debridement, the graft was meticulously sutured to the remaining dura mater rims in double-layered watertight fashion also covering

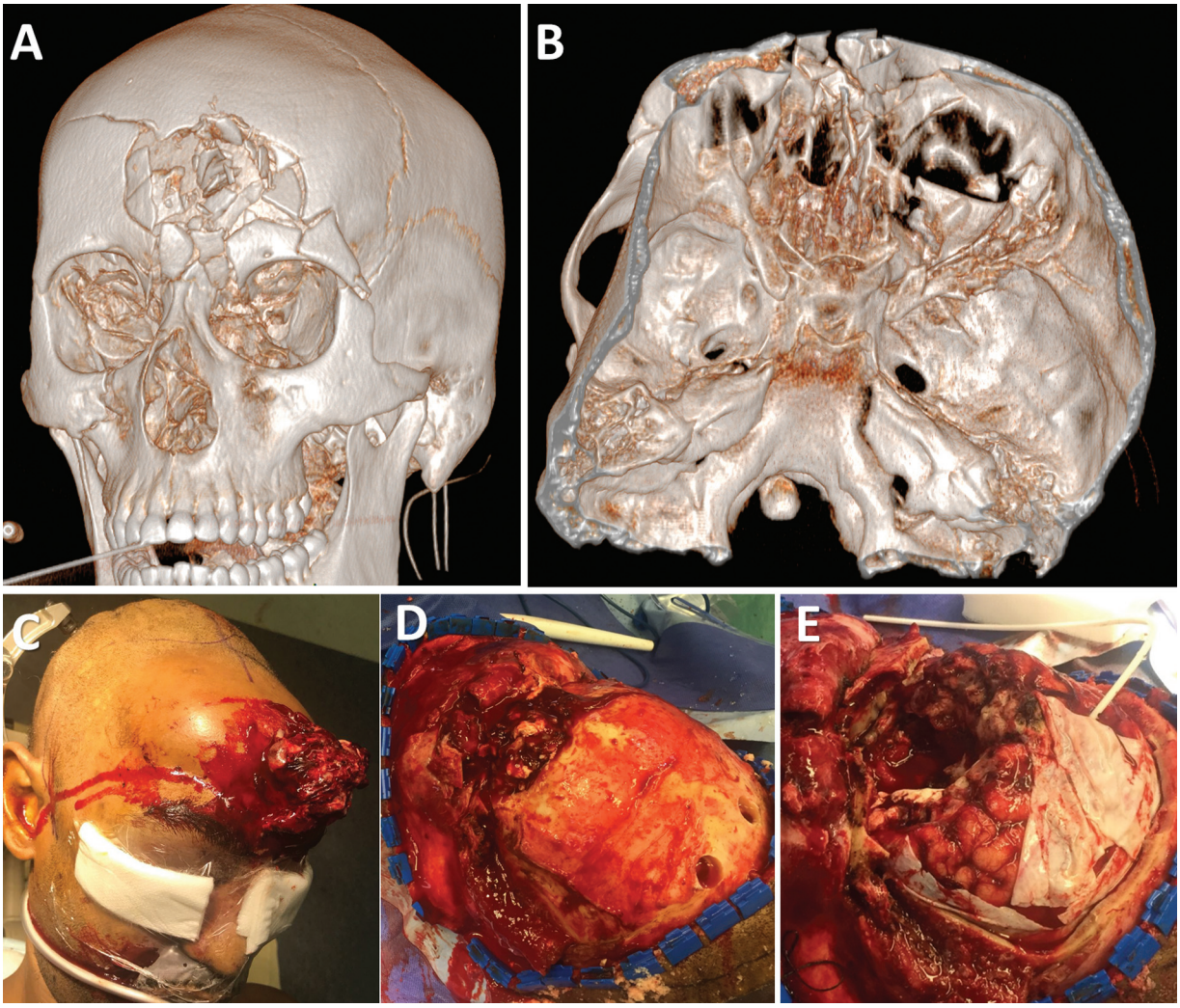

Fig. 1 First surgery. (**A**) Three-dimensional reconstruction (volume rendering) in bony window showing the comminuted fracture of the naso-ethmoido-maxillo-fronto-orbital complex (hemi-LEFORT II on the right and III on the left). (**B**) Three-dimensional reconstruction (volume rendering) in bony window showing the comminuted fracture of the anterior skull base. (**C**) The craniocerebral wound through which the mashed contused brain is extruding due to the raised intracranial pressure. (**D**) Operative view after retraction of frontal scalp. (**E**) Operative view after decompressive craniectomy, debridement, hemostasis, and washout.

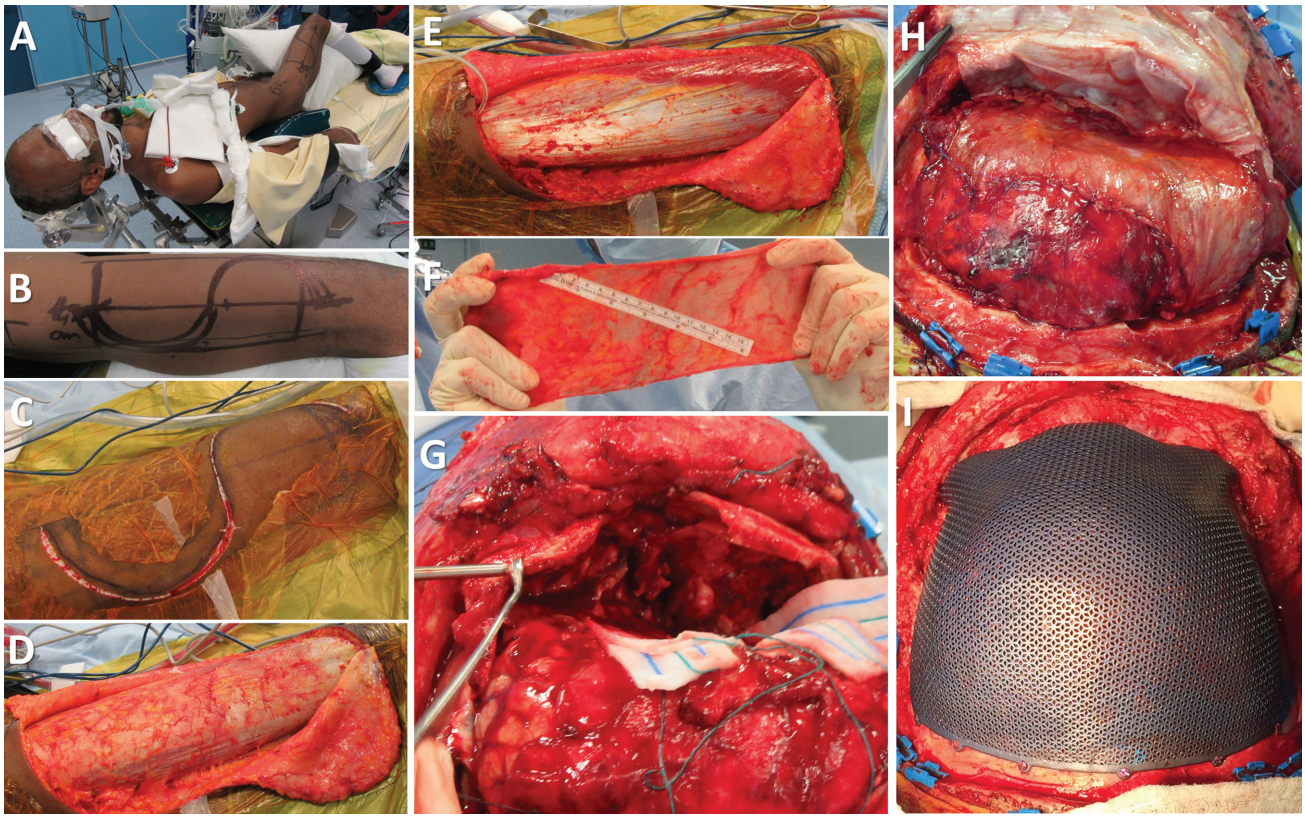

Fig. 2 Facia lata harvest followed by dural and cranial repair. (**A**) The patient is placed supine on the operating table with the right donor lower limb flexed at the hip and knee joints. The knee is brought to a 90-degree angle with a 10 to 15 degrees adduction at the hip joint and is supported from below to maintain this position. (**B**) The major reference anatomical landmarks, that is, the lateral femoral condyle and lateral crural septum, are identified and marked with a felt pen. An "S"-shaped incision line is drawn on the lateral aspect of the thigh with its axis parallel to the lateral crural septum indentation on the skin. (**C**) The skin flaps are sharply dissected off the fascia lata according to the dimensions of the graft size. (**D**) The thick band of the iliotibial tract is identified. The lateral margins of the fascial graft are first incised using slightly opened-tip scissors that are pushed along the longitudinally oriented fibers of the fascia distally and proximally through a small incision made at the fascia. (**E**) Exposure of the vastus lateralis muscle underneath. A drain is inserted via a separate stab wound, after which the skin is closed in layers. (**F**) Dimension of the graft harvested. (**G**) Operative view of the cranial and dural defects. (**H**) Operative view of the facia lata graft sutured. (**I**) Operative view of the third surgery 136 days later showing the titanium cranioplasty insertion.

the frontal sinus (►**Fig. 2H**). A 9.5×4.8 cm TachoSil fibrin sealant patch—Baxter—was placed on the anterior skull base. An external lumbar drain was inserted for 11 days and removed after endonasal endoscopic exploration ensuring the absence of CSF leakage. Sixty-one days after the initial admission, he was discharge to a rehabilitation unit. Both cranial and right thigh wounds healed uneventfully and the CSF leak never reoccurred. Twenty-two weeks after the initial trauma, a custom-made titanium cranioplasty was inserted (►**Fig. 2I**). Even though he recovered most of his personal autonomy, he has cognitive dysfunctions.

Discussion

Intracranial injuries caused by penetrating foreign bodies are relatively rare but has the highest mortality rate with a lethality above 90%.[4,5] Injuries caused by handguns, hunting rifles, and other "high-velocity" projectiles have been well-described, but trauma caused by "low-velocity" or nonmissile objects is particularly uncommon.[6] Patients wounded by bullet who survived rarely need complex neurosurgical management: small penetrating foreign missile objects are often left in place inside the skull. When transcranial penetration by low velocity objects occurred, common path goes through areas of thinned bone such as the temporal squama or the orbit.[7] Nonmissile injuries have lower velocities, and they impart most of their damage by tissue laceration. They carry better prognosis mainly because they release much less energy to the brain structures ($\frac{1}{2}mv2$). Penetrating nonmissile intracranial injuries caused by metallic foreign bodies are very rare among civilians. In present case, there was no foreign body to remove but an important craniocerebral wound to close. The goal of the first surgery was a prompt hemostasis, removal of bone fragments, focal debridement and, and decompression of neurovascular structures. However, as the pericranium was broadly damage, a tight dural closure was not possible to achieve at first. Luckily, the patient survived, but an important CSF leak failed to cease due to the large anterior skull base fracture associated with dilacerated dura mater that was not possible to treat during the first procedure. CSF leaks develop secondary to nonhealing dural tears and are classified as late complications of PBI. However, in some cases like in present one, it likely helped the patient to survive while providing an efficient safety valve for

the raised intracranial pressure even if he underwent a decompressive craniectomy. CSF leaks may happen through the entry or exit sites of the projectile as well as through the ear or nose when the mastoid air cells and the open-air sinuses have been damaged. They most commonly occur in association with basilar skull or naso-orbito-ethmoidal fractures.[5,8] This complication develops as a result of inadequate sealing of dura mater defect through normal tissue healing responses. Persistent CSF leak occurs in up to 28% of TBI patients, and if left untreated, they are highly predictive of intracranial infections, especially meningitis.[5,8] Surgical correction is, therefore, mandatory when they do not stop spontaneously or when they are refractory to temporary external CSF drainage either by ventricular or lumbar drain. During surgery, effort should be made to achieve a watertight dura mater closure. When the dura mater cannot be primarily sutured, allogeneic and synthetic grafts can be used. However, they can act as a foreign body and thus increase the risk of infection, especially in grossly contaminated wounds. As such, for the first surgical procedure of craniocerebral wound debridement of our patient, introduction of any synthetic material was not possible considering the highly septic environment for which the patient received broad-spectrum antibiotic prophylaxis by amoxicillin + clavulanic acid and gentamicin. In case of localized CSF leak, watertight repair can usually be achieved using transnasal endoscopic techniques.[9] However, in our patient, it was not possible as the dura mater was torn apart with a complex comminuted underlying fracture. Best tissue grafts are usually from autologous resources: pericranium, temporalis fascia, or fascia lata. Reparation using a pedicled temporalis muscle fascia graft and a free temporalis muscle flap was one time considered but finally denied regarding the previous extended bicoronal incision and the requirement of a clean and neat large piece of material.[10] Due to the need of a broad surface of material, our preference was directed toward facia lata, the source of choice especially when ample tissue is needed. The deep fascia encircles the thigh, and the fascia lata is a highly useful and abundant source of connective tissue. Its structure of densely packed and oriented fibers gives rise to a distinctive sturdy layer, but one that is sufficiently pliable to span irregularly shaped defects while providing excellent support that is maintained even when the graft is in the form of a narrow strip.[11] Large dural defects will require the harvesting of large sheaths of fascia lata as does a multilayer defect reconstruction at the anterior cranial fossa, such as the one required when the surgeon uses the extended anterior subcranial approach to the skull base after tumor ablation or trauma. The commonly used donor site area for obtaining fascia lata sheaths is the anterolateral aspect of the thigh just proximal to the knee joint. The graft is usually harvested via a lateral long vertical incision to allow adequate exposure. However, we choose to use the "S"-shaped technique designed by Amir et al that proved to be the right choice.[11,12] It provided us enough material to adequately replace the missing dura mater by a watertight double-layered graft easily suturable due to its thickness. The CSF leak ceased after autologous fascia reconstruction and external lumbar drain insertion. This was confirmed by the endonasal endoscopy. External lumbar drain insertion is an easy mean to decrease the CSF pressure and, to promote healing of the wound. Moreover, the graft was solid enough to enable 136 days after its implantation, a redo surgery without its damage for a titanium cranioplasty insertion. To the best of our knowledge, the successful surgical treatment of such a devastating penetrating brain injury has rarely been reported previously and may help neurosurgical team in the management of such complex patient treatment.

Conclusion

Penetrating injuries are uncommon; therefore, the management of such craniocerebral wound may be complex and nonstandardized. In case of persistent CSF leakage not amenable to endonasal endoscopic treatment, the use of a large piece of facia lata harvested on the thigh using an "S"-shaped incision is a simple, reliable, and inexpensive way to efficiently repair a large dura mater defect requiring neither special skills nor sophisticated instruments.

Ethical Approval

This case report complies with the guidelines for human studies and was conducted ethically in accordance with the World Medical Association Declaration of Helsinki. Ethical approval was not required for this case report in accordance with the French Scientific Research Ethics Committee policies. Informed consent for publication of this case report and any accompanied images was obtained from the patient.

Funding

None.

Conflict of Interest

None declared.

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