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CASE REPORTS

Bilateral Decompressive Craniotomy after Severe Traumatic Brain Injury with Post-Operatory Hydrocephalus and Ventriculitis: A Case Report and Literature Review

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Abstract

Introduction: Severe traumatic brain injury is characterized by pathological external forces that disrupt or alter brain function. Globally, an estimated 50 million cases of Severe traumatic brain injury occur annually.

Case presentation: This case study of an 18-year-old male patient, who suffered severe TBI in a motor vehicle accident, provides a valuable insight into the management of such cases.

The patient's initial assessment revealed a Glasgow Coma Scale score of 8, asymmetric but reactive pupils, and bilateral motor strength of 3/5, with no abnormalities noted in the cranial nerves.

Primary diagnosis by CT scan: severe traumatic brain injury with acute subdural hematoma in the right frontoparietal-temporal region, brain edema, and midline dislocation.

Secondary findings: Acute epidural hematoma in the left frontoparietal-temporal region.

Associated injuries: skull fractures, soft tissue contusions, and left lung contusion.

Surgical Procedures: The patient underwent the following procedures: 1. Right decompressive craniotomy for acute subdural hematoma. 2. Left decompressive craniotomy for acute epidural hematoma.

Conclusion: This case underscores the pivotal role of decompressive craniotomy in managing severe traumatic brain injury. Over the past two decades, this procedure has been instrumental in reducing secondary brain injury, enhancing cerebral perfusion, and managing elevated intracranial pressure. It has also been shown to decrease both mechanical ventilation dependence and intensive care unit length of stay, providing reassurance about its effectiveness.

Keywords: brain injury, bilateral decompressive craniotomy, epidural hematoma, brain edema, trauma, postoperative hydrocephalus

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Introduction

Severe traumatic brain injury (TBI) is a pathological condition resulting from external physical forces that disrupt or alter normal brain function. Severe traumatic brain injury (TBI) is characterized by pathological external forces that disrupt or alter brain function. [1].

This is relevant to the surgical treatment for TBI. It is estimated that approximately 50 million cases of traumatic brain injury (TBI) occur annually worldwide [2]. Among these, traumatic epidural hematomas are considered surgical emergencies, occurring in 14% to 35% of severe brain injuries. While the benefits of managing intraparenchymal brain injuries are still debated, surgical evacuation remains the gold standard treatment for patients with epidural hematomas [3].

Traumatic brain injuries can be classified by severity using the Glasgow Coma Scale (GCS): mild (13–15), moderate (9–12), and severe (<8). Morphologically, TBIs are categorized as either primary or secondary injuries. Primary injuries result from direct trauma, such as concussions or contusions, often accompanied by intracranial hematomas. Secondary injuries, however, are caused by complications like elevated intracranial pressure (ICP) and reduced cerebral perfusion, which can lead to ischemia. This cascade of secondary damage may induce hypotension, hypoxia, anemia, seizures, hypoglycemia, inflammatory responses, and hyperthermia, all of which disrupt the brain's metabolic mechanisms [4].

The management of epidural hematomas necessitates urgent surgical intervention, typically an emergency craniotomy informed by clinical and radiological findings. Surgical evacuation is crucial for lesions located in both the supratentorial and infratentorial regions, including the upper and lower tentorial compartments [5]. Over the past two decades, decompressive surgery has been instrumental in lowering ICP, enhancing cerebral perfusion, and alleviating secondary brain damage. This approach has been demonstrated to lessen the need for mechanical ventilation and shorten ICU length of stay, highlighting its importance in the management of severe TBI [6]. We present the case of an 18-year-old adolescent with severe head trauma and a left epidural hematoma, as well as a right subdural hematoma, whose diagnostic assessment was confirmed by imaging studies and was surgically treated with bilateral decompressive craniotomy.

Case Presentation

An 18-year-old Asian male patient was brought to the emergency department following a motor vehicle accident while riding his delivery scooter.

Upon initial assessment, the Glasgow Coma Scale (GCS) score was 8, and the patient presented with asymmetric but reactive pupils, indicating focal neurological deficits. Motor strength was 3/5 bilaterally, with no evidence of cranial nerve abnormalities.

Vital signs on admission were stable: body temperature of 38.0°C, respiratory rate of 20 breaths/min, heart rate of 78 bpm, blood pressure of 130/80 mmHg, and oxygen saturation of 97% on room air. Height/body length: 175.0 cm; body weight: 75.0 kg; BMI: 24.4 kg/m²; body surface area: 1.91 m²;

A computed tomography (CT) scan was performed to evaluate the need for surgical intervention.

Clinical Findings, Preoperative Diagnosis. The initial CT scan revealed;

Primary findings: severe TBI with acute subdural hematoma in the right frontoparietal-temporal region (40 cm³), brain edema, and a 10 mm midline shift to the left.

Associated injuries and physical examination: Skull fractures involving the vault base of the skull, soft tissue hematoma of the head, contusions of the torso and extremities, right hemiparesis, and a left lung contusion—diagnosis methods on admission by CT-scan.

*Primary diagnosis: S*evere TBI with acute subdural hematoma (40 cm³) in the right frontoparietal-temporal region, brain edema, and midline dislocation (10 mm to the left).

Secondary findings: Acute epidural hematoma in the left frontoparietal-temporal region. *Associated injuries:* skull fractures, soft tissue contusions, and left lung contusion.

Surgical Procedures: The patient underwent the following procedures:

1. Right decompressive craniotomy: Removal of a 60 cm³ acute subdural hematoma. 2. Left decompressive craniotomy: Removal of a 75 cm³ acute epidural hematoma. 3. Tracheostomy: Performed to secure airway management.

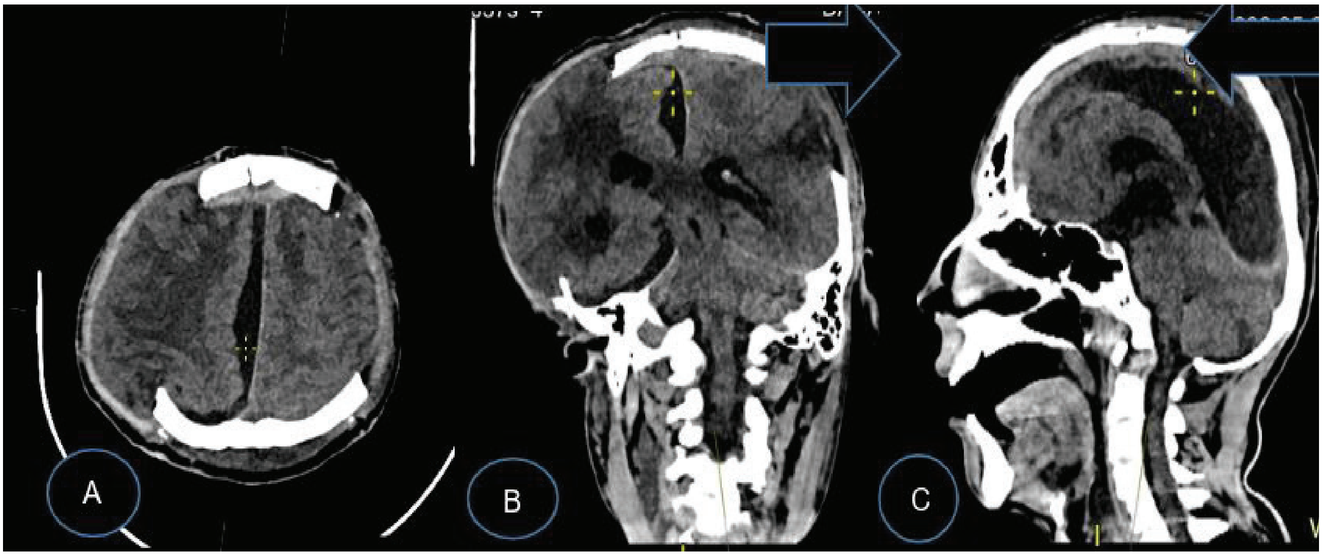

Figure 1. a) *Postoperative axial CT scan, bilateral right and left decompressive craniotomy, b) coronal image with expansion of the ventricles due to the presence of CSF, c) sagittal image with the presence of hydrocephalus*

4. External ventricular drainage: Placement in the right lateral ventricle for ICP management.

The postoperative diagnosis, Complications, and challenges: Brain edema and midline dislocation; Liquorrhea; Right lower lobe bronchopneumonia; Endobronchitis (mild intensity); Secondary meningoencephalitis; Septicemia; Moderate anemia.

Postoperative Imaging

Postoperative CT scans revealed the following: Additional findings included: Pronounced ventricular enlargement with asymmetric dilation (right > left); Hemorrhagic foci within the prolapsed brain tissue; Persistent skull fractures along the sagittal, coronal, and lambdoid sutures.

Second Control CT Findings

The second postoperative CT scan demonstrated changes consistent with prior surgical interventions. Evidence of decompressive craniotomy was observed in the frontoparietal-temporal region on the right, performed for the removal of a subdural hematoma, followed by craniotomy. The midline structures of the brain showed a shift to the right by 2 mm. In the left frontoparietal region, a residual epidural hematoma was identified, measuring approximately 7 mL in volume. Gas bubbles were visible in the subdural space, predominantly in the frontal areas, aligned in a crescentic configuration.

UCI Postoperative Follow-Up

Post-intervention considerations during the postoperative evaluation revealed significant findings, including prolapse of the right hemisphere of the brain through the post-trepanation defect, accompanied by transverse dislocation to the right. Diffuse edema of the brain's white matter was observed, more pronounced on the right side. Severe hydrocephalus was present, with possible occlusive pathology at the border of the spinal canal, and indirect signs of ventriculitis were noted, indicated by cerebrospinal fluid sedimentation.

Additionally, an increase in the ischemic area and surrounding edema was evident in the left parietal lobe. Partial regression of hemorrhagic brain lesions was observed, though single residual lesions persisted on the right side. Enlargement of the posterior epidural space in the cervical spine was noted at the level of C1. Furthermore, abnormal contents were detected in the cells of the right mastoid process.

Outcomes

Postoperative Procedures

A right external ventricular drain (EVD) was placed. Imaging revealed the proximal end of the drain positioned along the upper edge of the body of the right lateral ventricle, terminating near the transparent septum.

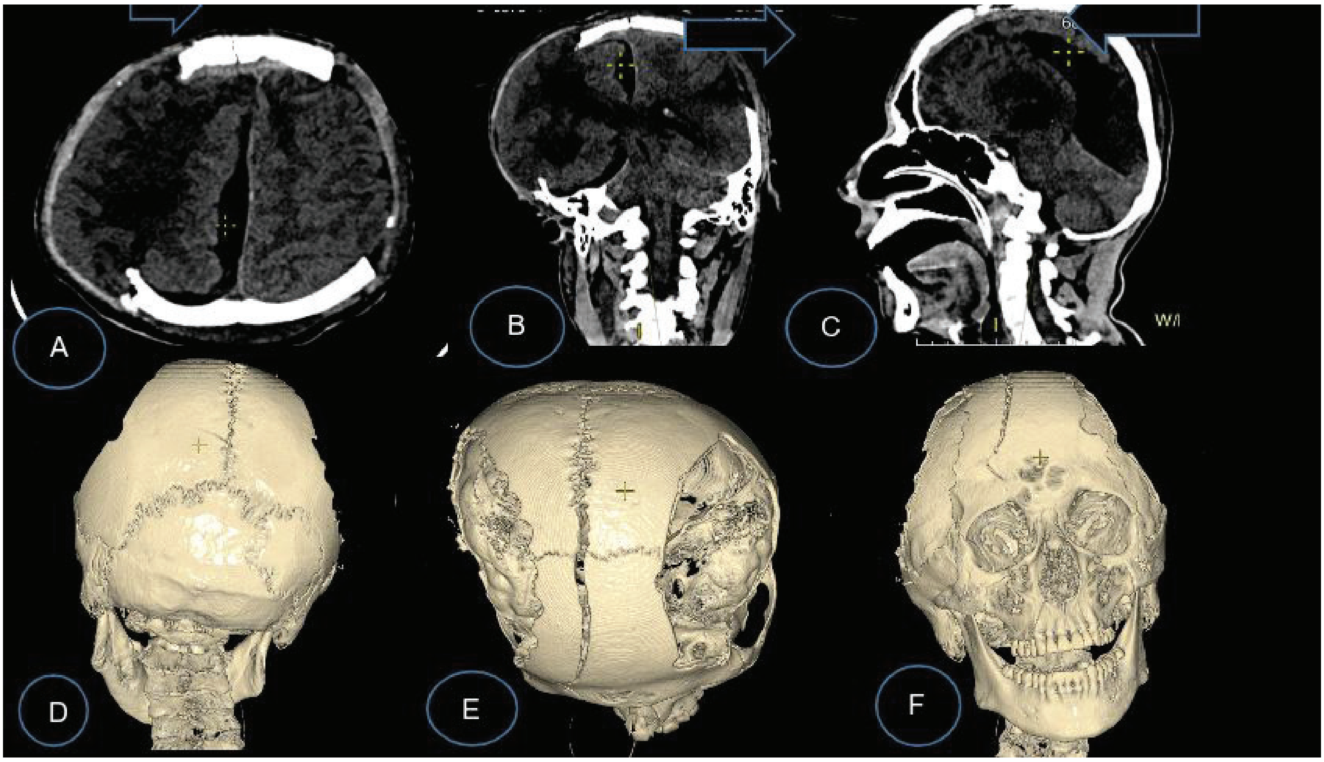

Figure 2. a) Axial: perifocal image of brain edema with prolapses of the cerebral hemisphere; b) coronal image: effacement of the ventricles and brain tissue space by edema; c) Sagittal projection confirming a good amount of CSF; d) 3D of the posterior cranial fossa; e) right and left decompressive craniotomy, posterior view; f) 3D frontal image with bilateral craniotomy.

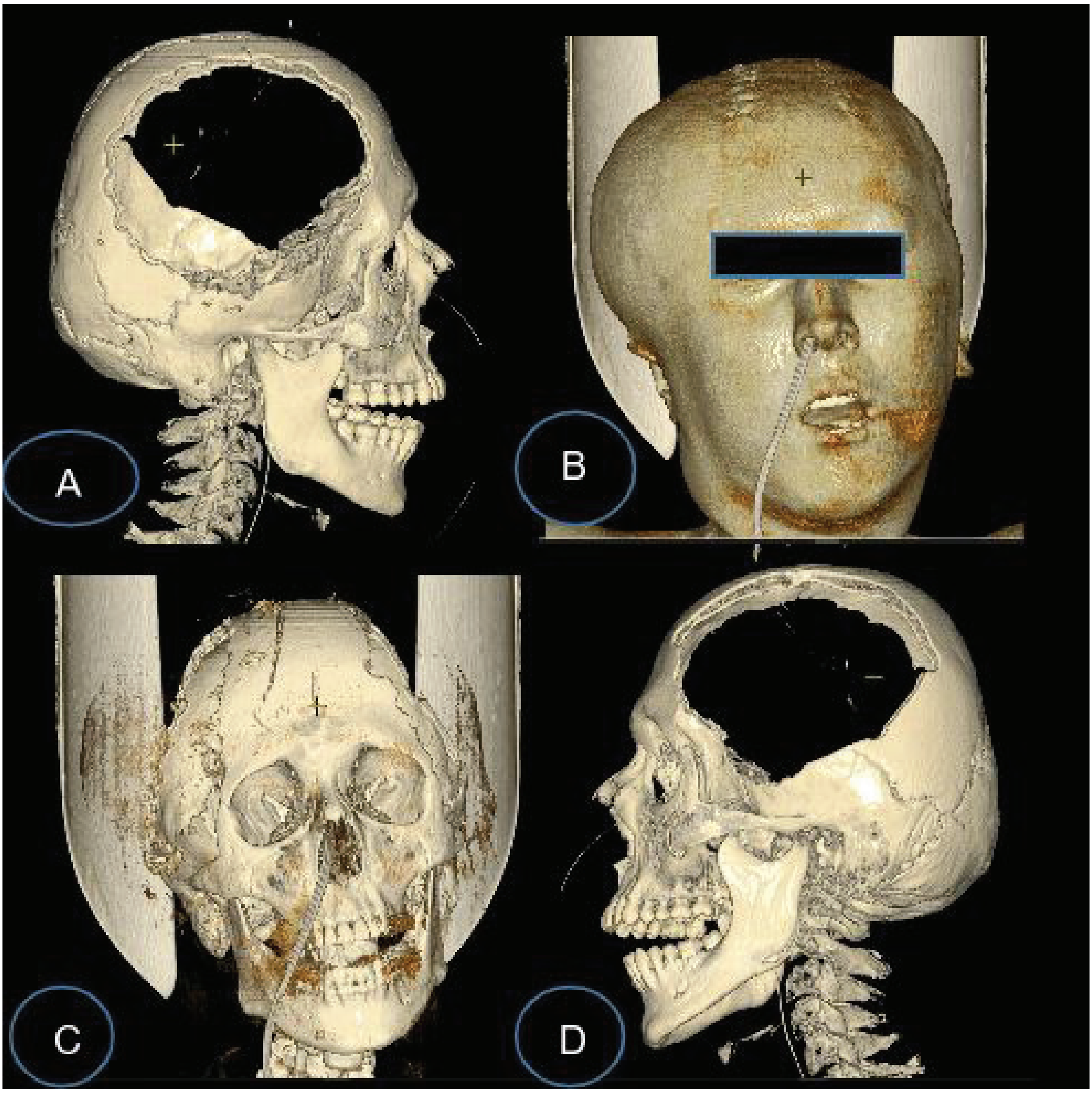

Figure 3. a) 3D reconstruction of a right decompressive craniotomy; b) 3D facial reconstruction of the patient with hydrocephalus, with nasogastric tube; c) 3D frontal view with right and left decompressive craniotomy; d) 3D reconstruction of a left decompressive craniotomy.

Repetitive lumbar puncture at the L4-L5 levels, with the presence of xanthochromic liquid, and the use of antibiotics for the benefit of the patient. These findings are illustrated in Figure 3.

Discussion

Patients undergoing decompressive surgery after severe traumatic brain injury (TBI) are statistically more likely to develop hydrocephalus. [7]. This complication is often associated with the use of large-diameter bone flaps during craniotomy, bilateral craniotomy, intraventricular hemorrhage involving interhemispheric regions, or contralateral cranial deformities, which may necessitate delayed cranioplasty. Careful monitoring is, therefore, critical for detecting and managing the progression of hydrocephalus in these patients [8, 14, 15].

A retrospective study conducted between 2017 and 2019 included 46 patients who underwent decompressive craniotomy. Among these, 71% were male, with a mean Glasgow Coma Scale (GCS) score of 7.59 (SD ± 2.97) at admission. Traffic accidents were the primary cause of injury in 76% of cases.

A GCS score of ≤8 was documented in 61% of patients, while 39% presented with a GCS score of>8. Additionally, 35% of patients had reactive pupils, whereas 58.7% exhibited anisocoria. The majority of patients (67%) were classified as Marshall Grade IV or higher, correlating with a mortality rate of 35%.

Patients with a Marshall grade ≤3 and CT scan findings indicating less severe injury showed significantly better outcomes ($P < 0.001$). Patients younger than 50 years also had more favorable outcomes ($P = 0.039$). [9].

In severe TBI, intracranial hypertension can result in cerebral herniation or arterial infarction if left untreated. Decompressive craniotomy is effective in preventing these complications and may reduce the likelihood of requiring secondary interventions [10].

However, the biomechanical consequences of decompressive craniotomy are complex and nonlinear. The procedure alters the properties of brain tissue, including deformation and midline displacement. Intracranial pressure (ICP) values during herniation have been reported to range from 18 to 80 mmHg, with an average of 36.4 mmHg, while herniated brain tissue displacement may range between 27 and 127 mm [11, 16].

Surgical Approach

Peri-intervention: The patient was positioned supine with the head turned to the left. Following antiseptic preparation, an arcuate "trauma flap" skin incision was made in the right frontoparietal-temporal region.

The skin flap was folded back to expose the surgical site. Three burr holes were created along the fracture line of the parietal bone, and a 10×10 cm bone flap was excised using a Gigli saw. Upon opening the dura mater, approximately 60 mL of subdural hematoma was evacuated, including 20 mL of liquid blood that flowed spontaneously and 40 mL of violet-black clots.

The dura mater was sutured around the perimeter of the bone window. Upon inspection, the brain appeared swollen, with a bluish-burgundy hue and weak pulsation. Numerous cortical contusions and areas of active venous bleeding were observed, including damage to the superior sagittal sinus and associated venous structures.

A similar procedure was performed for the left hemisphere, where a 75 cm^3 epidural hematoma was evacuated. Following both decompressive craniotomies, active silicone drainage was placed subcutaneously, and the wound was closed in layers.

Decompressive craniotomy and cranioplasty are associated with complications, including hydrocephalus. Patients with severe head trauma who undergo decompressive craniotomy often experience reduced ICP and shorter ICU stays compared to those managed with conventional craniotomy. Despite these benefits, patients with such conditions may still have lower Glasgow Outcome Scale (GOS) scores, reflecting poor functional recovery [12].

Primary decompressive craniotomy can yield favorable outcomes in 46% of cases. However, to optimize results, prediction models, such as nomograms, should be utilized to identify patients at high risk of poor outcomes within six months. Complications such as subdural effusion, external herniation, and hydrocephalus are common in severe TBI and are associated with poor prognoses and functional impairments [13, 17].

Conclusion:

The postoperative status of this patient highlights key observations compared to findings in similar studies:

- The placement of an external ventricular drain (EVD) in the right lateral ventricle was associated with the development of isolated intracerebral hematomas in the right frontal lobe along the drainage tract.
- The prolapse of the right hemisphere through the post-trepanation defect was reduced, with an associated decrease in transverse midline dislocation to the right.
- Hemorrhagic infiltration in the right parietal lobe increased against the backdrop of diffuse white matter edema, more pronounced on the right side.
- Severe hydrocephalus was reduced, though an occlusive component at the spinal canal border could not be excluded. Signs of ventriculitis, indicated by cerebrospinal fluid sedimentation, were also observed.
- The ischemic area and surrounding edema in the left parietal lobe showed partial regression.
- The posterior epidural space at the cervical spine level (C1) remained expanded.
- Content in the cells of the right mastoid process decreased.

The severity of the patient's condition is attributed to edematous dislocation syndrome caused by severe TBI, compounded by secondary meningoencephalitis. Multicomponent intensive therapy in the ICU, with close monitoring of hemodynamic and laboratory parameters, remains essential.

The treatment strategy has been coordinated with ICU specialists, and continued CT monitoring is recommended should the patient's condition deteriorate. Unfortunately, the patient succumbed due to the severity of the injuries caused by severe head trauma, plus the constant complications established.

Declarations

Conceptualization, M.A. BC.JJA, JFH., D.E.S.; Methodology, D.E.S., G.S.; software, D.E.S., and G.C.; validation, ES. MP. I.B., G.S., and B.C; Formal analysis, G.C., B.E., and DRC.; investigation, D.E.S. Resources, EC, and E.S. Data curation, EC. G.S.; writing—original draft preparation, D.E.S., writing—review and editing, IB, D.E.S., visualization, AR, N.B., supervision, G.C., EC, I.B.

Data Availability: All Data can be requested from the corresponding author

Competing interest: The authors have no competing interests in this report.

Consent for publication: It was obtained

Ethical Approval: The ethical guidelines outlined in the World Medical Association's Declaration of Helsinki and the principles of Good Clinical Practice were followed. Ethical guidelines outlined in the World Medical Association's Declaration of Helsinki Good Clinical Practice were strictly followed, at the Moscow City Clinical Hospital №68, Demikhova V.P. in Moscow at the Ref. number 1857, dated 02.07.1992, No. 2300-1 (As amended on 06.11.2021). Ensuring that the patient's closest relative provided informed consent before the patient participated in this case report.

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Abbreviations

TBI - Traumatic Brain Injury; GCS - Glasgow Coma Scale; ICP - Intracranial Pressure; ICU – Intensive Care Unit; CT - Computed Tomography; BMI – Body Mass Index; CSF - Cerebrospinal Fluid; ECD - External Ventricular Drain;

References

1. Sohrabi, C., Mathew, G., Maria, N., Kerwan, A., Franchi, T., Agha, R. A., & Collaborators (2023). The SCARE 2023 guideline: updating consensus Surgical CAse REport (SCARE) guidelines. *International journal of surgery (London, England)*, *109*(5), 1136–1140. https://doi.org/10.1097/JS9.0000000000000373
2. Khellaf, A., Khan, D. Z., & Helmy, A. (2019). Recent advances in traumatic brain injury. *Journal of neurology*, *266*(11), 2878–2889. https://doi.org/10.1007/s00415-019-09541-4
3. Choi, D. H., Jeong, T. S., Kim, W. K., & KNTDB Investigators (2022). Clinical Outcome of Patients Diagnosed Traumatic Intracranial Epidural Hematoma With Severe Brain Injury (Glasgow Coma Scale ≤8) Who Undergo Surgery: A Report From the Korean Neuro-Trauma Data Bank System. *Korean journal of neurotrauma*, *18*(2), 153–160. https://doi.org/10.13004/kjnt.2022.18.e62
4. Koipapi, S., Mmbaga, B. T., Chilonga, K., Msuya, D., Rabiel, H., Nkoronko, M., Urasa, S., Saria, V., & Chugulu, S. (2023). Outcomes of traumatic brain injury patients with acute epidural and subdural hematoma who underwent burr hole surgery: A two-year study at Kilimanjaro Christian Medical Centre, Tanzania. *World neurosurgery: X*, *21*, 100257. https://doi.org/10.1016/j.wnsx.2023.100257
5. Yoon, S. Y., Seok, J., Kim, Y., Lee, J. S., Lee, J. Y., Lee, M. S., & Kim, H. R. (2023). Surgical management of supratentorial and infratentorial epidural hematoma in Korea: three case reports. *Journal of trauma and injury*, *36*(4), 399–403. https://doi.org/10.20408/jti.2023.0073
6. Hashmi, S. M. M., Nazir, S., Colombo, F., Jamil, A., & Ahmed, S. (2022). Decompressive Craniectomy for the Treatment of Severe Diffuse Traumatic Brain Injury: A Randomized Controlled Trial. *Asian journal of neurosurgery*, *17*(3), 455–462. https://doi.org/10.1055/s-0042-1756636
7. Ki, H. J., Lee, H. J., Lee, H. J., Yi, J. S., Yang, J. H., & Lee, I. W. (2015). The Risk Factors for Hydrocephalus and Subdural Hygroma after Decompressive Craniectomy in Head-Injured Patients. *Journal of Korean Neurosurgical Society*, *58*(3), 254–261. https://doi.org/10.3340/jkns.2015.58.3.254
8. Rufus, P., Moorthy, R. K., Joseph, M., & Rajshekhar, V. (2021). Post Traumatic Hydrocephalus: Incidence, Pathophysiology and Outcomes. *Neurology India*, *69*(Supplement), S420–S428. https://doi.org/10.4103/0028-3886.332264
9. Shah, D. B., Paudel, P., Joshi, S., Karki, P., & Sharma, G. R. (2021). Outcome of Decompressive Craniectomy for Traumatic Brain Injury: An Institutional-Based Analysis from Nepal. *Asian journal of neurosurgery*, *16*(2), 288–293. https://doi.org/10.4103/ajns.AJNS_392_20
10. Lan, Z., Richard, S. A., Li, Q., et al. (2020). Outcomes of patients undergoing craniotomy and decompressive craniectomy for severe traumatic brain injury with brain herniation: A retrospective study. *Medicine*, *99*(43), e22742. https://doi.org/10.1097/MD.0000000000022742
11. Lambride, C., Christodoulou, N., Michail, A., Vavourakis, V., & Stylianopoulos, T. (2020). Decompressive craniectomy of post-traumatic brain injury: an in silico modelling approach for intracranial hypertension management. *Scientific reports*, *10*(1), 18673. https://doi.org/10.1038/s41598-020-75479-7
12. Cooper, D. J., Rosenfeld, J. V., Murray, L., et al. DECRA Trial Investigators, & Australian and New Zealand Intensive Care Society Clinical Trials Group (2011). Decompressive craniectomy in diffuse traumatic brain injury. *The New England journal of medicine*, *364*(16), 1493–1502. https://doi.org/10.1056/NEJMoa1102077
13. Jost J. N. (2022). Primary Decompressive Craniectomy After Traumatic Brain Injury: A Literature Review. *Cureus*, *14*(10), e29894. https://doi.org/10.7759/cureus.29894
14. Encarnación-Santos, D., Chmutin, G., Chmutin, E., Bozkurt, I., & Chaurasia, B. (2025). Management of hydrocephalus after cerebellar pilocytic astrocytoma in a pediatric patient: case report and literature review. *OncoReview*, *14*(4(56), 88-92. https://doi.org/10.24292/01.OR.144990024
15. Encarnación Santos, D., Chmutin, G., & Chaurasia, B. (2024). Skull base-cranio-facial trauma with dura mater repair after subsequent CSF leaking, diagnosis, treatment, and outcomes: A systematic review of the literature. *Romanian Neurosurgery*, *38*(3), 317–327. https://doi.org/10.33962/roneuro-2024-057
16. Encarnación-Santos, D. Pachev, M. Bozkurt, I. et al. Acute Subdural Haematoma Emergency Care Regarding Glial Cystic Changes: A Case Report and Literature Review. Kerala Surgical Journal 31(1):p 26-29, Jan–Jun 2025. | DOI: http://dx.doi.org/10.4103/ksj.ksj_1_25
17. Santos D, Chmutin G, Aybar Peña D. et al. Letter to the Editor Regarding "Management of Hydrocephalus with Ventriculoperitoneal Shunts: Review of 109 Cases of Children". World Neurosurg. 2022 Aug;164:465-466 https://doi.org/10.1016/j.wneu.2022.04.085