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Case Report

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From Critical to Stable: Case Report on Managing Traumatic Brain Injury (TBI) Caused by Gas Cylinder Explosion

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ABSTRACT

Background: The widespread adoption of LPG cylinders in India has improved clean cooking practices, but has also led to an increased risk of gas cylinder explosion-related injuries. These incidents often result in traumatic brain injuries (TBIs), which pose significant challenges for emergency and surgical management.

Methods: We report the case of a 22-year-old male who sustained severe head trauma following a gas cylinder explosion. The patient presented with a Glasgow Coma Scale (GCS) score of E1V1M2, a lacerated wound with exposed brain parenchyma, and evidence of subdural hemorrhage.

Results: Emergency surgical intervention included a bilateral frontal lobectomy and decompressive craniectomy. Post-operative care involved transfusion of blood products and intensive monitoring. Over a 14-day hospital stay, the patient's GCS progressively improved to E4V5M6, culminating in a successful discharge.

Conclusion: This case underscores the importance of rapid diagnosis, surgical intervention, and critical care in managing blast-induced TBIs. Early and aggressive management can result in significant neurological recovery, even in cases with poor prognosis.

Key-words: Traumatic brain injury, gas cylinder explosion, decompressive craniectomy, bifrontal lobectomy, Glasgow Coma Scale

INTRODUCTION

The number of registered LPG consumers in India increased significantly, rising from 106 million in 2008–2009 to 263 million by 2017–2018. This growth has played a role in reducing pollution-related mortalities. However, the presence of LPG cylinders in households has also led to a heightened risk of severe injuries from cylinder explosions. According to the "Support for Clean Cooking in India 2020" report, such incidents remain a concern.

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Data from the National Crime Records Bureau (NCRB) highlights that cylinder bursts account for about one-fifth of fire-related accidents in India. In 2022, there were 7,566 fire accidents, with 1,567 caused by short circuits and 1,551 attributed to gas cylinder explosions.

Common non-penetrating traumatic brain injuries (TBI) from such explosions include diffuse axonal injury, cerebral contusions, and subdural hematomas [1]. Blast-related TBIs are categorized as primary, secondary, tertiary, or quaternary. Primary injuries result from blast pressure waves affecting air-filled organs, causing issues like ruptured eardrums. Secondary injuries involve trauma from debris or projectiles, while tertiary injuries occur when the body is forcefully displaced and impacts objects. Quaternary injuries include burns, inhalation of toxic gases, and complications of prior medical conditions or structural collapses [2,3].

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The brain's delicate structure, combined with bony protuberances in the inferior cranial vault, makes it highly vulnerable to injury [4]. Diffuse axonal injuries result from shearing forces on axons and vessels during closed head injuries. Cerebral contusions arise from brain movement within the skull, as seen in coup-contrecoup injuries, while subdural hematomas occur due to the tearing of bridging veins between the brain and dural sinuses [4,5]. Skull fractures, whether open or closed, can lead to complications like epidural hematomas, especially with blunt trauma to the temporal region. These injuries present with a range of symptoms, from mild concussion to severe outcomes like coma or death [4].

Case Presentation

A 22-year-old male patient presented to the Emergency Department (ED) on 2nd June 2024 with a history of head trauma due to the explosion of a gas cylinder at approximately 8 AM while working in a garage. He was initially taken to a nearby primary care government hospital, where a CT scan was performed, and the attendants were counselled about the life-threatening nature and poor prognosis of the condition. The attendants chose to transfer the patient to another hospital and discharged him against medical advice. He arrived at DY Patil Hospital Navi Mumbai for surgical management at around 4 PM, the same day.

Upon arrival, the patient had a history of loss of consciousness but no reported seizures, as informed by his brother. His pulse rate was 120 per minute, and his blood pressure was 90/70 mmHg. His Glasgow Coma Scale (GCS) score was E1V1M2, and his pupils were 1 to 2 mm, sluggishly reactive to light. The patient was immediately administered intravenous fluids and medications, including two pints of blood (NS 2 pints at 120 cc/hour), Inj. Mannitol 300 cc IV stat, Inj. Levetiracetam 1 gram IV, Inj. Ceftazidime TZ 1.25 gm IV, Inj. Pantoprazole 40 mg IV, Inj. Ondansetron 4 mg IV, and Inj. Metronidazole 100 cc IV. Additionally, he received two pints of packed RBCs. The patient was intubated within 15 minutes, but there was no improvement in the GCS, which remained at E1V1M2. His pupils remained sluggishly reactive to light.

Hematological and urine examinations were sent for analysis in preparation for surgical management. On wound examination, a lacerated wound measuring 30x20x5 cms was noted, with exposed brain parenchyma and blood oozing from the wound. His blood pressure was 110/90 mmHg, pulse rate was 100 per minute, and oxygen saturation was 100% on CPAP. Cardiovascular examination revealed normal S1 and S2 heart sounds, and bilateral air entry was noted on respiratory examination.

A repeat CT scan of the head without contrast was performed, as some time had passed since the initial scan. The repeat CT showed no change in the size of the subdural hemorrhage in the left parietal region, along with linear hyper density of blood attenuation noted in the cortical sulci over the bilateral frontal lobes and the interhemispheric fissure. No significant changes were observed in the subarachnoid hemorrhage.

The patient was shifted to the emergency operation theatre, and bilateral frontal lobectomy with emergency decompressive craniectomy was decided. Under sterile precautions, the surgical site was prepared and draped. A bifrontal displaced fracture with an exposed frontal lobe was noted. A subperiosteal flap was dissected along the fractured bone, and the incision was extended along the side of the fractured frontal bone. Small bone fragments were removed, and the exposed, non-functional bifrontal brain parenchyma was excised along with the hematoma. Hemostasis was achieved using bipolar cautery. Galeal cuts were made on either side for the approximation of the flaps. The wound was closed in layers, and the skin was closed using approximately 50 staples. A sterile dressing was applied.

Intraoperatively, the patient was transfused with one unit (200 ml) of blood, and two units of fresh frozen plasma, and vital signs were closely monitored. The patient was then shifted to the ICU for post-operative care. One additional unit of blood was transfused post-operatively. After 24 hours, the patient's GCS improved to E2VtM4. A post-operative CT scan showed a craniectomy defect involving the entire frontal bone and right parietal bone, with overlapping surgical staples. An extra-axial mixed fluid collection measuring approximately 1.7 cm in maximum width, with a few air foci, was seen at the operative site. There were hyper densities of blood attenuation within the collection. When compared with the preoperative CT scan, there was a significant reduction in the extra calvarial herniation of the bilateral frontal lobes.

Post-operatively, the patient's GCS was E2VtM4, with sluggishly reactive pupils. Vital signs were stable, with a blood pressure of 120/90 mmHg and a pulse rate of 100 per minute. On post-operative day 4, the patient's GCS improved to E3VtM5, and he was extubated. On day 5, the GCS was E4VtM5, showing further improvement. By day 10, the GCS had improved to E4VtM6, and the patient was discharged on day 14.

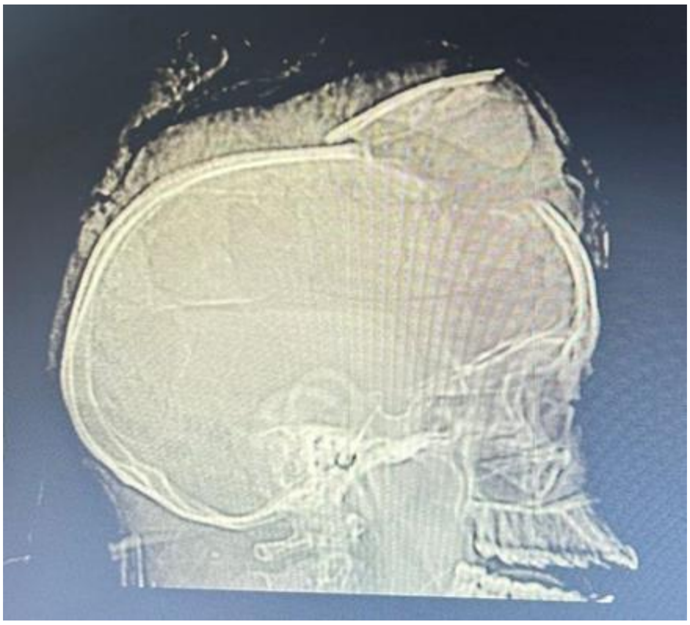

Fig. 1: Pre-operative CT scan image showing lacerated wound exposing frontal lobe

Fig. 2: Post-operative image showing removed frontal lobe & bone, with staples visible.

Fig. 3: (A) Pre- Operative image showing extent of Injury; **(B)** Intraoperative image showing dissection post removal of subperiosteal flap & fractured bone; **(C)** Evacuation of Hematoma & portions of excised Non- functional Brain Parenchyma; **(D)** Post Operative image showing survival & complete recovery.

DISCUSSION

The effect created due to strong blast injury was reported earlier during World War I by physicians working in their field hospitals. They highlighted conditions varying from mild to moderate severity in the form of concussion, post-concussion syndrome (PCS), mild traumatic brain injury (MTBI), post-traumatic stress disorder (PTSD), and acute stress disorder (ASD) [6,7]. Concussion occurs due to trauma leading to alteration in mental status as defined by The American Academy of Neurology (AAN) which might not involve the loss of consciousness [8]. Explosions result from the rapid conversion of solids or liquids state chemicals into gases state, energy released during conversion is called a blast overpressure wave or blast wind. This wave creates an initial high-pressure shock wave, termed the "positive phase impulse," which compresses the surrounding air [6]. High-energy explosions generate shock waves with a shattering effect called "brisance," and the severity of blast injuries depends on the impulse magnitude [9]. Serial Glasgow Coma Scale (GCS) scoring, can signal CNS deterioration and the need for neurosurgical intervention. Outcomes are worse with persistently low or declining GCS compared to consistently high or improving scores. Most MTBI patients present to the ED with a GCS of 15, indicating no obvious CNS injury [10].

Diagnosing MTBI requires a high index of suspicion and neurocognitive tools like the Military Acute Concussion Evaluation (MACE) and Standardized Assessment of Concussion (SAC), which assess orientation, memory, concentration, and recall [11]. The 2002 American College of Emergency Physicians (ACEP) policy discourages skull radiographs for MTBI due to low sensitivity, recommending non-contrast CT scans for specific cases in updated guidelines [10,12]. The 2008 ACEP evidence-based policy stated that existing literature is insufficient to recommend MRI for evaluating acute MTBI in the ED, despite MRI's potential to improve detection sensitivity by up to 30% [12]. Limitations include cost, availability, and accessibility, though advancements in technology may increase MRI's role in the future [12].

In severe cases, secondary brain injuries can result from hypotension and hypoxemia, requiring aggressive airway management, oxygenation, ventilation, and fluid therapy. Routine hyperventilation is no longer recommended for brain-injured patients [13]. A period of relative rest for 2–5 days after a concussion is recommended, followed by a gradual increase in physical activity. Acetaminophen is typically advised for headaches, with other pharmacologic options including NSAIDs, isometheptene, triptans, propranolol, tricyclic antidepressants, or Divalproex. Depression may respond to selective serotonin reuptake inhibitors, while meclizine may help with dizziness or vertigo. Nonpharmacologic options like relaxation techniques and cognitive-behavioural therapy can also be beneficial [14,15]. American College of Emergency Physicians (ACEP) is developing evidence-based guidelines for ED discharge instructions following MTBI to improve standardization [12].

CONCLUSIONS

Severe cranial trauma from gas cylinder explosions necessitates prompt surgical intervention and comprehensive multidisciplinary care. This case demonstrates that, despite an initially poor prognosis (GCS of E1V1M2), timely surgical management and intensive post-operative support can lead to significant neurological recovery. The patient's gradual improvement to a GCS of E4V5M6 highlights the potential for positive outcomes even in life-threatening scenarios. Public awareness of safety measures and enhanced emergency response infrastructure are essential to reducing the burden of such injuries and improving survival rates.

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Ethics Approval and Consent to Participate- Ethical approval for conducting the study was obtained from the Dr. D.Y. Patil Medical College & Hospital, Navi Mumbai, Maharashtra, India. Written informed consent was obtained from the patient for his participation in the study.

Consent for Publication- The patient's informed consent has been acquired for the publication of the case details, clinical images, and relevant medical information. All efforts have been made to ensure patient confidentiality, and any identifying information has been appropriately anonymized.

CONTRIBUTION OF AUTHORS

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