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Case Report

Anesthetic Management in Patient with Traumatic Brain Injury undergoing Elective Spinal Surgery

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Abstract

The incidence of traumatic brain injury that concurrent with injuries such us traumatic spinal injuries is relatively high. When considering anesthetic management for patients with acute traumatic brain injury undergoing non-brain surgery procedures, understanding of the implications of traumatic brain injury on anesthesia management is essential for achieving favorable surgical results while minimizing the risk of secondary brain injury to ensure patient safety and optimal outcomes. We report a case of a 25 years old man who presented with decrease of consciousness 3 days prior admission to the hospital after sudden fall in the bathroom. Complaints were accompanied with vomiting, weakness and paresthesia in both bilateral upper extremities and lower extremities. Supportive examination revealed an epidural hematoma at regio frontoparietal sinistra, minimal subdural hematomas at regio anterior falx cerebelli and bilateral tentorium cerebelli, subgaleae hematomas at regio bilateral parietal, with multiple cervical fracture at the C5 level with associated cervical canal narrowing. Due to the minor intracranial bleeding with no significant symptoms for days, patient then scheduled for elective C4-C6 laminectomy and posterior stabilization surgery. Anesthesia management for patient with traumatic brain injury that undergoes non-brain surgery comes with challenges, mainly on how to prevent secondary brain injury and minimizing complications. Comprehensive perioperative planning and vigilant monitoring are essential to ensure patient safety and optimal outcomes.

Keywords: Anesthesia management, traumatic brain injury, traumatic spinal injury, spine surgery

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Introduction

The interconnected biomechanical relationship between the cranial and spinal structures increases the likelihood of concurrent traumatic brain and spinal injuries.[1] The incidence of traumatic brain injury concurrent with injuries such us traumatic spinal injuries is relatively high between 40 to 74%.[2] Patients with severe traumatic brain injury are at a particularly high risk of sustaining cervical spine injuries. The most frequently affected segments in spinal cord injuries alongside traumatic brain injury were the cervical and thoracic spines.[3] When considering anesthesia management for patients with traumatic brain injury undergoing non-brain surgery procedures, a thorough understanding of the implications of traumatic brain injury on anesthesia management is essential for achieving favorable surgical results while mitigating the risks of secondary brain injury to ensure patient safety and optimal outcomes. This case report highlights key anesthetic considerations in a patient with TBI undergoing elective spinal surgery, resulting in a favorable clinical outcome.[4] General anesthesia is preferred

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for non-brain surgery, and the choice of agents should be carefully considered.[5] The application of these strategies can greatly improve recovery outcomes and decrease complications related to traumatic brain injuries.[4] This case report highlights key anesthetic considerations in a patient with TBI undergoing elective spinal surgery, resulting in a favorable clinical outcome.

Case

History

A 25-year-old male, weighting 60 kg. The patient had a history of transient decreased of consciousness 3 days before admission to the hospital after a sudden fall in the bathroom. Complaints were accompanied by vomiting, weakness, and tingling in both the upper and lower extremities. Complaints of defecation and urination (-), history of fever (-), and history of hypertension (-).

Physical Examination

The patient was fully alert with Glasgow Coma Scale score of 15 was wearing a cervical collar neck. Neurological examination revealed hypesthesia below the C5 dermatome, with a Numeric Rating Scale (NRS) pain score of 2/10. Pupils were equal, round, and reactive to light (3 mm/3 mm). Airway assessment revealed Mallampati class II, with intact dentition and no loose teeth. Respiratory examination demonstrated symmetrical chest movement with a respiratory rate of 19–20 breaths per minute, vesicular breath sounds bilaterally, and no adventitious sounds. Oxygen saturation was 97–98% on room air. Cardiovascular examination showed a blood pressure of 137/76 mmHg and a pulse rate of 72 beats/min, with regular rhythm and no murmurs.

Abdominal examination was unremarkable. Urinary function was normal without catheterization. Musculoskeletal examination revealed limited neck movement due to pain and cervical immobilization, with motor strength graded 0/5 in both upper and lower extremities.

Supporting Exams

Laboratory results showed hemoglobin 15.3 g/dL, hematocrit 43%, leukocyte count 9,400/mm³, platelet count 407,000/mm³, sodium 142 mmol/L, potassium 4.4 mmol/L, chloride 99 mmol/L, and normal coagulation parameters. Chest radiography was within normal limits. Cervical spine radiography demonstrated an anterior compression fracture at the C5 vertebral level with associated soft tissue swelling. Head computed tomography revealed an epidural hematoma in the left frontoparietal region, minimal subdural hematomas along the anterior falx cerebelli and bilateral tentorium cerebelli, subgaleal hematomas in the bilateral parietal regions, and cervical canal narrowing at the C5 level. The patient was diagnosed with mild traumatic brain injury, bilateral linear parietal fractures, epidural hematoma, and multiple cervical fractures at the C5 level (type B), with an American Society of Anesthesiologists (ASA) physical status II. The planned procedure was elective C4–C6 laminectomy and posterior stabilization under general anesthesia with endotracheal intubation.

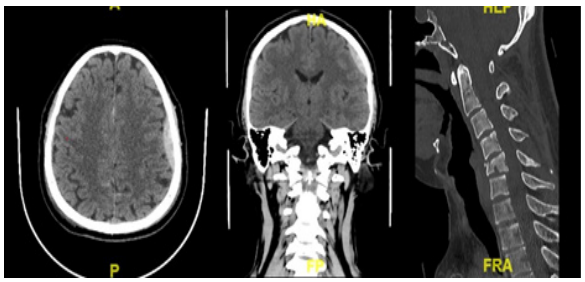

Figure 1. Overview of Head CT scan Examination Results

Anesthesia Management

Pre-anesthesia preparation started with obtaining informed consent at the preoperative visit, fasting the patient, preparing ready-to-use packed red blood components, installing an infusion line with crystalloid fluid, and preparing the intensive care room for postoperative care. Preparation in the operating room started with the preparation of anesthetic machines, video laryngoscopes, tubes, airway devices, tape, introducers, connections, endotracheal tubes (ETT), anesthetic and emergency drugs, and syringe pumps. Intraoperative monitoring was performed using intra-arterial blood pressure (IABP), ECG,

capnograph ($etCO_2$), oxygen saturation (SpO_2), and intraoperative neuromonitoring (IONM).

On the operating table, blood pressure was found to be 137/78 mmHg, pulse 70 beats per minute, oxygen saturation 98%, then given intravenous Propofol TCI Schneider mode effect 5 mcg/mL, Remifentanil TCI Minto mode effect 4ng/mL then this was followed by intravenous Rocuronium 60 mg and lidocaine 90 mg. Intubation using MacGrath laryngoscope size no.3 with in-line stabilization technique to preserve c-spine control and intubated using ETT no 7,5 fixation at the lip border 21 cm. Ventilator : VCV mode rate 14 VT 450 ml PEEP 5 oxygen : air with FiO_2 40%. During surgery, the patient was administered continuous total intravenous anesthesia (TIVA) using propofol TCI schneider mode effect 2–5mcg, dan remifentanil TCI Minto mode effect 3–4ng. The patient was in the supine position for 2 h and then changed to the prone position for the rest of the surgery. Intraoperative fluid maintenance using 2 mL/kg/hr of Ringer's Fundin. Hemodynamics during surgery were stable, with systolic blood pressure was 115–125 mmHg, diastolic blood pressure was 70–78 mmHg, pulse was 64–70 beats per minute, oxygen saturation of 99%, and $etCO_2$ was 29–32. The operation lasted for 6 hours, with a total blood loss of 700 mL. The total fluid intake was 2000 mL, 200mL of PRC and total urine output was 3000 mL.

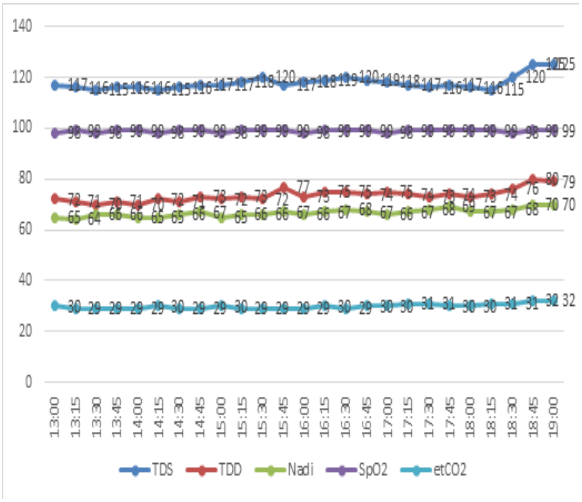

Figure 2. Hemodynamic Graph during Surgery

Post-Surgical Management

After the surgery was completed, the patient was calm, fully conscious (GCS 15), and demonstrated intact cough and swallowing reflexes. Vital signs were stable with blood pressure 121/68 mmHg, pulse 71 beats/min, respiration 18 times/min, and oxygen saturation 99%. The patient was successfully extubated in the operating room before transfer to the intensive care unit. Postoperative analgesia consisted of continuous intravenous fentanyl at 25 µg/h, intravenous paracetamol 1 g every 8 hours, and oral parecoxib. Twenty-four hours postoperatively, the patient remained hemodynamically stable, fully alert, with an NRS pain score of 1/10 and no new neurological deficits. Postoperative laboratory examination revealed hemoglobin 14.3, hematocrit 42,5, leucocytes 18000, and platelets 365000. On postoperative day two, the patient was transferred to the general ward.

Discussion

Surgical intervention after a spinal injury has the potential to minimize neurological damage; however, it encompasses several important factors. Currently, there are no established guidelines regarding the role, timing, or type of decompression in cases of acute spinal injury. The decision for surgical intervention is determined by neurological decline and the degree of spinal column abnormalities. In this case, the patient had neurological deficits, such as tingling and weakness in both the upper and lower extremities, which limited his daily living activities. Thorough consideration of the risks and benefits of spinal surgery must be made, especially in patients with concurrent traumatic brain injury.[2]

Managing patient with traumatic brain injury that undergoes non-brain surgery procedure comes with many challenges, mainly on how to prevent secondary brain injury and minimizing complications. General anesthesia often preferred in non-brain surgery procedures because it can provide a controlled environment that allows for continuous monitoring and adjustment of intravascular volume, blood pressure, and other vital parameters that can impact cerebral

perfusion and intracranial pressure. Moreover, general anesthesia can facilitate complete muscle relaxation and avoid painful stimuli, reducing stress responses that could exacerbate secondary brain injuries. In this case, we also use intraoperative neuromonitoring (IONM) as a standard of care to prevent neural pathway injury during neurosurgical interventions.[4,5] Its value extends beyond perioperative diagnosis of neurological complications in high-risk patients, offering the additional advantage of enabling timely intervention to preserve neural tissue before irreversible damage ensues. Given the elevated risk of injury to adjacent healthy structures in spinal surgery, the integration of anesthetic techniques with neurophysiological monitoring represents a critical strategy to mitigate intraoperative complications.[6]

In this patient, it is important to note that cerebral autoregulation recovery after traumatic brain injury may be delayed in some patients, making the injured brain susceptible to secondary brain injury after the initial trauma.[7] There are few strategies to significantly lower the risk of secondary brain injury in patients with traumatic brain injury who undergo general anesthesia for non-brain surgery operations. During the preoperative and intraoperative periods, ensuring adequate cerebral perfusion pressure (CPP) and cerebral blood flow (CBF) is critical. Monitoring blood pressure and administering intravenous fluids or medications can help maintain stable hemodynamics during anesthesia. Blood pressure must be maintained within the normotension range to prevent brain shrinkage or edema, and intravascular volume deficit must be corrected before the induction of anesthesia to prevent hypotension.[7–10] The anesthetic technique used in this case was total intravenous anesthesia using propofol, remifentanil, and rocuronium, which can help maintain cerebral perfusion pressure, cerebral blood flow, depth of anesthesia, and pain control to minimize secondary brain injury.

In patients with traumatic brain injury, minimizing the risk of elevated intracranial pressure (ICP) during surgical procedures is essential, including the use of proper positioning during anesthesia, such as elevating the head by 30 degrees and employing medications that can reduce ICP.[7] In this case, we ensured no compression of the jugular venous drainage in both the supine and prone positions. During surgery, we ensured adequate ventilation to avoid hypoxia and hypercapnia by monitoring the $etCO_2$ within normal range of 30–35.7,10 As there were no complications during the procedure, we decided to extubate. After the surgery was completed, the patient was fully conscious with a GCS of 15, calm, with good cough and swallowing reflexes and normal breathing, and was extubated in the operating room. We ensured that there was no spike in hemodynamic parameters, bucking, straining, or coughing during extubation.[7,8,10] Postoperative analgesia was administered as multimodal analgesia using intravenous fentanyl 0,5 mcg/kg.BW, intravenous paracetamol (20 mg/kg.BW), and oral COX-2 inhibitor (in this case, parecoxib) to maintain adequate pain control.

Conclusion

An integrated and cautious anesthetic approach is needed to manage concurrent traumatic brain injury and cervical spinal fractures undergoing spinal surgery. Strategies such as careful induction with in-line stabilization, choice of anesthesia drugs, maintenance of stable hemodynamics, and close monitoring of cerebral perfusion and ventilation play vital roles in preventing secondary brain injury. In addition, intraoperative fluid balance, positioning, and oxygenation contributed to favorable surgical outcomes, with the patient safely extubated in the operating room and transferred to the intensive care unit without complications.

Patients with traumatic brain injury undergoing non-brain surgery procedures require meticulous anesthetic planning tailored to both brain and spinal cord pathologies. Early anticipation of potential risks, multimodal analgesia for postoperative pain control, and prevention of secondary brain injury remain key priorities for optimizing recovery and minimizing complications. The outcome achieved in this patient illustrates that a comprehensive multidisciplinary approach

with attention to neuroprotective strategies can be resulted in stable hemodynamics, effective pain management, and favorable neurological recovery.

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