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Case Series

Anaesthesia Section

Various Anaesthetic Techniques used in the Management of Traumatic Diaphragmatic Hernia: A Series of Three Cases

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ABSTRACT

Traumatic diaphragmatic hernia is relatively uncommon and occurs most commonly after a road traffic accident (5%). Diaphragmatic rupture is mostly associated with vital organ injuries such as the liver, spleen, lungs, bones, pelvis, and brain, which can be severely damaged. The anaesthetic management of a patient presenting with traumatic diaphragmatic hernia depends on any associated vital organ injuries. Hereby, the author present a case series of three patients with traumatic diaphragmatic hernia with different presentations managed accordingly. In the first case, a 37-year-old male presented with diaphragmatic hernia and cervical spine fracture following a road traffic accident. Awake fibreoptic intubation was performed with utmost care to avoid further injury to the cervical spine. After intubation, positive pressure ventilation was given with low tidal volume to avoid barotrauma and to expand the atelectatic lung. The second case involved a 48-year-old male with a history of falling from a height one week prior, who presented with right-sided diaphragmatic rupture and a liver contusion. Intubation was performed using a left-sided double-lumen tube, and one-lung ventilation was applied to facilitate thoracotomy. A thoracic paravertebral block was administered to alleviate postoperative pain, providing good pain relief. In the third case, a 56-year-old male with a known case of Chronic Obstructive Pulmonary Disease (COPD) presented to the hospital following a road traffic accident. The patient had lung contusion and haemopneumothorax with poor pulmonary reserve, and required emergency surgical repair. Combined spinal-epidural anaesthesia was preferred over general anaesthesia, as intubation may cause bronchospasm and life-threatening complications in COPD patients.

Keywords: Combined spinal-epidural, Double-lumen tube, Fibreoptic intubation, Thoracic paravertebral block

INTRODUCTION

Diaphragmatic rupture mainly occurs due to blunt trauma or penetrating injury to the abdomen, which can manifest as respiratory distress or obstruction. Diaphragmatic herniation is more commonly observed in the left dome (90%) than in the right dome (10%), primarily due to the protective effect of the liver and right kidney [1]. Here, three patients presented with traumatic diaphragmatic hernia and associated vital organ injuries, where various anaesthetic techniques were employed for management.

In the first case, awake fibreoptic intubation was performed to secure the airway as the patient presented with a cervical spine fracture. Intravenous analgesics were administered for postoperative pain relief. The second case involved a right thoracotomy approach, where a left-sided double-lumen tube was inserted, and one-lung ventilation was employed to facilitate thoracotomy. Additionally, a thoracic paravertebral block was administered for postoperative analgesia. The third case featured a patient with known COPD who presented with lung contusion and poor pulmonary reserve. In this scenario, combined spinal-epidural anaesthesia was preferred over general anaesthesia.

CASE SERIES

Case 1

A 37-year-old male reported to the Emergency Room (ER) following a road traffic accident. The patient presented with complaints of difficulty in breathing and dizziness. After initial resuscitation, the patient was diagnosed with a cervical spine fracture and diaphragmatic rupture. The patient was immediately shifted to the operating theatre. On examination, his pulse rate was 102 per minute, and his blood pressure was 130/80 mmHg. He exhibited tachypnea with a respiratory rate of 25/min, a breath-holding time of 12 seconds, and a Glasgow Coma Scale (GCS) score of 14/15. Auscultation revealed significantly reduced air entry on the left side. Chest X-ray showed right-sided heart shift and bowel loops in the left mid and lower thorax. CT abdomen and chest revealed defects in the left hemidiaphragm with herniation of the stomach and hepatic flexure of the colon, along with collapse of the left lung. MRI of the spine showed a wedge compression fracture of the C1-C2 vertebrae, which could be managed conservatively.

Awake nasal fibreoptic intubation was planned considering the cervical spine fracture, and the procedure was explained to the patient. In the operating room, standard monitors were attached, and two wide-bore cannulas were secured. The patient received intramuscular injection of glycopyrrolate 0.2 mg and intravenous bolus dose of dexmedetomidine 1 mcg/kg over 10 minutes. Airway anaesthesia was achieved by bilateral superior laryngeal nerve block with 2% lignocaine (2 mL on each side) and a transtracheal injection of 4 mL of 4% lignocaine. Lignocaine jelly was used for topicalisation of the nasal cavity. With the patient in the supine position, Fibreoptic Bronchoscopy (FOB) was performed from the head end of the patient through the right nostril. A preloaded 7 mm endotracheal tube was guided into the trachea without any complications. The patient remained co-operative and comfortable throughout the procedure, and the position of the endotracheal tube was confirmed with FOB. The patient was induced with intravenous fentanyl 100 mcg, propofol 140 mg, and atracurium 40 mg, and maintained on a mixture of nitrous oxide ($N2_O$) and oxygen (O_2) in a ratio of 50:50, along with sevoflurane at 1-2% concentration.

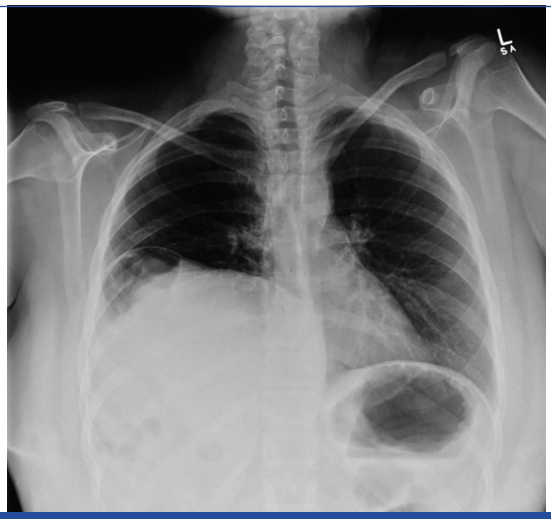
Surgery was preceded by a left thoracoabdominal incision while the patient remained in the supine position. The herniated contents were reduced into the intra abdominal cavity, and the diaphragm was repaired. Positive pressure of 30 cm H_2O was applied to expand the collapsed left lung, resulting in improved air entry on the left side. Vital signs were maintained throughout the procedure. For postoperative analgesia, the patient received 1 g of intravenous paracetamol and 100 mg of tramadol intramuscularly. After adequate recovery, the

patient was extubated and shifted to the postoperative ward. The patient was discharged on the 8th postoperative day.

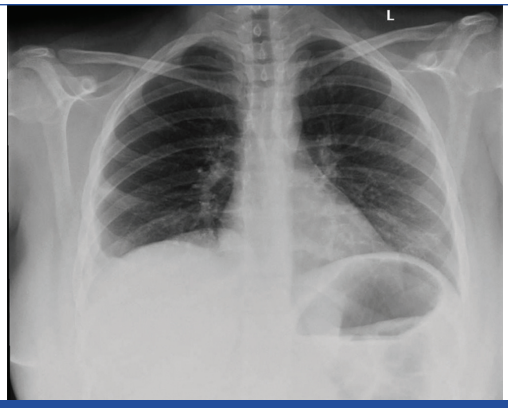
Case 2

A 48-year-old male presented to the ER with complaints of breathing difficulty and abdominal pain persisting for the past five days. He reported a fall from a height one week prior. On examination, his heart rate was 106/min, blood pressure was 100/60 mmHg, respiratory rate was 28/min, and his Glasgow Coma Scale (GCS) score was 15/15. Tenderness was noted over the right upper quadrant of the abdomen, and decreased breath sounds were heard on the right side. Chest X-ray revealed elevation of the right hemidiaphragm with herniation of the colon and segmental atelectasis of the middle and lower lobes of the right lung [Table/Fig-1]. Computed Tomography (CT) chest confirmed right diaphragmatic hernia with herniation of the hepatic flexure of the colon, segmental atelectasis of the middle and lower lobes of the right lung, and subcapsular hematoma of the right lobe of the liver. Right thoracotomy [2] and hernia repair were planned with one-lung ventilation. A nasogastric tube was inserted, and central venous cannulation was performed on the left internal jugular vein. An arterial line was secured on the right radial artery. The patient was resuscitated with crystalloids.

After preoxygenation, the patient was induced with glycopyrrolate 0.2 mg, midazolam 1 mg, fentanyl 100 mcg, propofol 160 mg, and atracurium 40 mg. A left-sided double-lumen tube (Robertshaw No. 39) was inserted, and mechanical ventilation was initiated in volume control mode with a tidal volume of 6 ml/kg, respiratory rate of 14/minute, and Positive End-Expiratory Pressure (PEEP) of 5 cm H2O. Anaesthesia was maintained with a mixture of $N2_O$:O_2 - 50% and 1-2% sevoflurane. The patient was then positioned in the left decubitus position, and surgery was performed through a right thoracotomy approach. Lung isolation technique using 100% oxygen was employed in the initial stage of the surgery. Once the contents were reduced and the diaphragmatic defect was repaired, both lungs were ventilated. A right-sided chest tube was inserted, and at the end of the surgery, a 20 G catheter was placed in the thoracic paravertebral space under surgical visualisation for postoperative analgesia. The catheter was activated with 10 mL of 0.2% ropivacaine, repeated every 6th hour postoperatively. Vital signs remained stable throughout the procedure. After turning the patient supine, ventilation to both lungs was resumed with a positive pressure of 30 cm H_2O to expand the collapsed lung. The patient was extubated on the table and shifted to the Intensive Care Unit (ICU) for observation. The paravertebral catheter was removed on the second postoperative day. A chest X-ray taken on the 5th postoperative day showed complete inflation of the right lung [Table/Fig-2]. The patient was discharged on the 10th postoperative day.



[Table/Fig-1]: Chest X-ray showing elevation of the right hemidiaphragm with herniation of colon, and segmental atelectasis of middle and lower lobe of right lung.



[Table/Fig-2]: Chest X-ray taken on 5th postoperative day showing complete inflation of right lung.

Case 3

A 56-year-old male presented with a history of a road traffic accident three hours prior. He was diagnosed with a left lung contusion and left diaphragmatic hernia. The patient was taken to the operating room for diaphragmatic hernia repair. He had a known history of chronic obstructive pulmonary disease and was using a foracort rotahaler. On examination, his heart rate was 95 beats per minute, blood pressure was 140/100 mmHg, respiratory rate was 24 breaths per minute, breath-holding time was 15 seconds, and his Glasgow Coma Scale (GCS) score was 15/15. Tenderness was noted over the left upper quadrant, with decreased air entry and bilateral crepitations on the left side. CT findings showed gastric herniation into the left thoracic space, contusion of the left lung, and haemopneumothorax. An intercostal drainage tube was placed on the left side before the patient was shifted to the operating theatre. The patient received nebulisation with bronchodilators preoperatively.

Considering the lung contusion and COPD, a combined spinal epidural technique was planned. The patient was positioned in the left lateral position, and under aseptic precautions, a 20 G epidural catheter was inserted at the T7-T8 level. A test dose of 3 mL of 0.375% ropivacaine was administered. A subarachnoid block was performed at the L3-L4 space with 3 mL of 0.5% bupivacaine and 20 mcg of fentanyl. A sensory level of T4 was achieved. The patient was sedated with intravenous midazolam (0.04 mg/kg) and received oxygen at a rate of 6 L/min via a Hudson's mask. After positioning the patient in the supine position, the surgeons entered the abdominal cavity using a left thoracoabdominal approach. A tear was found in the left dome of the diaphragm, and the contents were reduced into the abdominal cavity. The patient remained comfortable throughout the procedure. The patient experienced minimal hypotension, which was managed with two bolus doses of ephedrine (12 mg) and crystalloid infusion. At the end of the surgery, the epidural was activated with a continuous infusion of 0.2% ropivacaine at a rate of 4 mL per hour for two days. The patient was shifted to the surgical ICU for observation and then transferred to the ward on the 2nd postoperative day after removal of the epidural catheter. The patient was discharged on the 7th postoperative day.

DISCUSSION

Traumatic diaphragmatic hernia (TDH) most commonly occurs after road traffic accidents (5%) and is often associated with vital organ injury. The clinical presentation depends on the extent of diaphragmatic rupture, herniation of hollow viscera, and vital organ injury [3]. Anaesthesia for TDH is challenging, particularly when it is associated with vital organ injury. The pathophysiology of TDH includes respiratory depression due to decreased diaphragmatic function, herniation of abdominal contents into the thoracic cavity, atelectasis [4], mediastinal shift to the right, circulatory collapse, and cardiac compromise. Various anaesthesia methods have been proposed for managing these patients. The routine recommended methods include awake intubation, nasogastric tube insertion

[5], avoidance of mask ventilation, controversial administration of nitrous oxide to maintain spontaneous ventilation after induction of anaesthesia, and one-lung ventilation [6,7]. Spontaneous ventilation after induction of anaesthesia, recommended by Lobb TR et al., carries the risk of cough, which could worsen the diaphragmatic rupture [8]. Yoshidome K et al., reported a case in which the patient's lung herniated into the abdominal cavity following prolonged mechanical ventilation, indicating that positive pressure ventilation could prevent herniation of abdominal viscera into the thoracic cavity [9]. Positive pressure ventilation can prevent viscera from entering the thoracic cavity, and spontaneous ventilation is no longer recommended [10]. Al Skaini MS et al., reported that negative intrathoracic pressure may worsen diaphragmatic rupture and herniation of abdominal contents into the thoracic cavity [11].

Temizel F et al., and Williams DJ and Sandby-Thomas MG recommended the use of a double-lumen tube and one-lung ventilation with precautions to prevent perioperative hypoxia and hypercarbia, although the insertion of a double-lumen tube is time-consuming and associated with a higher failure rate due to mediastinal shift causing difficult intubation [12,13]. Pahwa D et al., recommended regional anaesthesia to minimise the need for postoperative ventilatory support associated with general anaesthesia [14]. Regional anaesthesia reduces the risk of aspiration, as patients with TDH are considered to have a full stomach. TDH can be incidentally detected during preoperative investigations or intraoperatively when patients undergo other surgeries such as laparotomy or laparoscopy [15]. The first case was managed with utmost care to avoid further injury to the cervical spine. Awake fibreoptic intubation was performed, and positive pressure ventilation was given with low tidal volume to prevent barotrauma and expand the atelectatic lung. In the second case, a double-lumen tube was used for intubation, and one-lung ventilation was applied to facilitate thoracotomy. Intubating patients with mediastinal shift using a double-lumen tube poses a challenge to anaesthesiologists. The surgeon inserted a thoracic paravertebral catheter through a separate skin puncture, one level below the incision site. A 20 G catheter was threaded in the extrapleural space under direct visualisation, and the tip was positioned to cover two intercostal spaces [16].

To alleviate postoperative pain, 10 mL of 0.2% bupivacaine was administered as bolus doses every six hours. Early initiation of postoperative chest physiotherapy was possible due to effective pain relief, which aided in lung expansion, reduced pulmonary infection, and prevented atelectasis. In the third case, a known COPD patient with lung contusion and haemopneumothorax and poor pulmonary reserve underwent emergency surgical repair. Combined spinal-epidural anaesthesia was chosen over general anaesthesia to avoid bronchospasm and life-threatening complications in COPD patients. Thoracic epidural anaesthesia was recommended by Mineo TC et al., for thoracic surgeries as it improves diaphragmatic function and provides better postoperative analgesia compared to patient-controlled intravenous administration of opioids [17]. Few studies have been published on the use of regional techniques for surgical anaesthesia in diaphragmatic hernia repair. The present case series demonstrates the successful management of TDH with lung contusion using combined spinal-epidural anaesthesia.

CONCLUSION(S)

The anaesthetic management of traumatic diaphragmatic hernia depends on the extent of diaphragmatic rupture, associated vital organ injury, and the patient's co-morbid conditions. The present case series describes three patients with different presentations of traumatic diaphragmatic hernia and their respective management approaches. Nasogastric tube insertion, mechanical ventilation with low tidal volume, and intercostal drainage are preferred anaesthetic management techniques. Regional anaesthesia is a successful alternative to general anaesthesia, particularly in high-risk patients with poor pulmonary reserve. Regional anaesthesia provides better pain relief, allowing for early initiation of physiotherapy and reducing the risk of atelectasis. The ultimate goals of present study was to provide adequate pain relief, promote lung expansion, prevent atelectasis, and minimise the need for postoperative ventilatory support, thus reducing morbidity.

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