Cureus
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Open Access Case Report

Thoracic Epidural Anesthesia for Emergent Laparotomy in a Patient with Advanced Chronic Obstructive Pulmonary Disease (COPD) and Recent Pneumothorax

Review began 10/26/2026
Review ended 11/04/2026
Published 11/11/2026

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DOI: 10.7759/cureus.119466

David G. Paixão [1], Alice Nunes Carvalho [2], Luísa Lages [2], Glória Ribeiro [2], Inês Pereira [2]

1. Anesthesiology, Portuguese Institute of Oncology of Lisbon Francisco Gentil, Lisbon, PRT 2. Anesthesiology, Saint Mary's Local Health Unit, Lisbon, PRT

Corresponding author: David G. Paixão, davidgpaixao@gmail.com

Abstract

Patients with advanced chronic obstructive pulmonary disease (COPD) undergoing major abdominal surgery are at particularly high risk of perioperative respiratory complications, especially when general anesthesia and positive-pressure ventilation are required. We report the anesthetic management of a 64-year-old man with advanced COPD and extensive emphysematous lung disease complicated by recurrent bilateral pneumothoraces, including a large right-sided pneumothorax two months before surgery. The patient presented with an acute right-sided colonic volvulus associated with radiological signs of bowel ischemia and underwent emergent ileocolic resection through laparotomy. Given his extremely limited respiratory reserve, extensive bullous disease, and recent pneumothorax, thoracic epidural anesthesia combined with dexmedetomidine and ketamine sedation was selected to avoid tracheal intubation and positive-pressure ventilation. Postoperative recovery was uneventful, with stable respiratory status on his baseline oxygen requirement, effective epidural analgesia, and no relevant postoperative complications or organ dysfunction. He was discharged on postoperative day seven to a respiratory rehabilitation facility. This case illustrates that, in carefully selected patients, neuraxial anesthesia combined with titrated sedation may provide an alternative to general anesthesia when avoidance of positive-pressure ventilation is considered particularly important.

Categories: Anesthesiology
Keywords: advanced copd, bowel ischemia, bullous emphysema, emergency laparotomy, positive pressure ventilation, postoperative pulmonary complications, recurrent bilateral pneumothorax, regional anesthesia, thoracic epidural anesthesia

Introduction

Patients with advanced chronic obstructive pulmonary disease (COPD) undergoing major abdominal surgery present a significant anesthetic challenge. COPD is characterized by persistent expiratory airflow limitation, while emphysema involves destruction of alveolar walls and loss of elastic recoil, further promoting air trapping. Severe emphysematous disease is associated with markedly reduced respiratory reserve, impaired gas exchange, increased work of breathing, and an increased risk of postoperative pulmonary complications [1]. These risks become particularly relevant when general anesthesia, tracheal intubation, neuromuscular blockade, and positive-pressure ventilation are required and may be even greater in patients with extensive bullous emphysema and a history of recurrent pneumothorax [1,2]. During positive-pressure ventilation, insufficient time for expiration may cause air to remain trapped before the next breath, progressively increasing lung volume (dynamic hyperinflation) and leaving residual positive pressure at the end of expiration (intrinsic positive end-expiratory pressure). These changes may impair ventilation and reduce venous return to the heart. In patients with extensive bullous emphysema, excessive lung distension may also rupture fragile air spaces, causing barotrauma and pneumothorax [3,4]. Postoperative respiratory muscle impairment, residual anesthetic effects, pain, and opioid administration may further contribute to respiratory failure [1,2].

In this setting, neuraxial anesthesia, combined with carefully titrated sedation, may be considered in selected patients to avoid tracheal intubation and positive-pressure ventilation. However, its use as the primary anesthetic technique for major emergency abdominal surgery remains uncommon. Potential limitations of this technique include incomplete blockade, discomfort during visceral manipulation, and hypotension associated with sympathetic blockade. Sedation may also impair ventilation and airway protective reflexes. Inadequate surgical anesthesia or respiratory deterioration may therefore necessitate urgent conversion to general anesthesia. This approach requires careful patient selection, close coordination with the surgical team, continuous monitoring, and a predefined rescue strategy with immediate access to airway management and mechanical ventilation.

We present the anesthetic management of a patient with advanced COPD and extensive bilateral

emphysematous disease complicated by recurrent bilateral pneumothoraces who underwent emergent laparotomy under thoracic epidural anesthesia.

Case Presentation

A 64-year-old man was admitted for emergent laparotomy due to an acute right-sided colonic volvulus with radiological evidence suggestive of bowel ischemia.

His medical history was relevant for Global Initiative for Chronic Obstructive Lung Disease (GOLD) 4E COPD [5] with a Body-mass index, airflow Obstruction, Dyspnea, and Exercise capacity index (BODE) of 7 [6]. The disease was attributed to active smoking, with a cumulative exposure of approximately 70 pack-years. His most recent pulmonary function tests showed very severe airflow obstruction, with a forced expiratory volume in one second (FEV1) of 22% of predicted, a Tiffeneau index (FEV1/forced vital capacity) of 26% of predicted, and a diffusing capacity for carbon monoxide (DLCO) of 41% of predicted. The patient reported modified Medical Research Council (mMRC) grade 3 dyspnea [7], with significant exertional limitation, including breathlessness after walking short distances on level ground and requiring frequent pauses during routine activities. His six-minute walk distance was approximately 300 meters. Thoracic computed tomography (CT) showed severe destructive emphysema, predominantly in the upper lobes, with centrilobular and paraseptal components and large bullae. A ventilation-perfusion scan had previously shown marked heterogeneity of ventilation and perfusion, compatible with severe functional pulmonary impairment.

His respiratory history was further complicated by recurrent spontaneous pneumothoraces. The first episode occurred on the left approximately nine years before the current admission, followed one year later by a right-sided episode requiring video-assisted thoracoscopic pleurodesis. A further left-sided episode occurred six years later. Two months before the current admission, he presented to the emergency department with acute worsening dyspnea and respiratory failure in the setting of a respiratory infection and COPD exacerbation complicated by a new large spontaneous right-sided pneumothorax (Figure *1*). He was treated with antibiotics and corticosteroids, while the pneumothorax was managed with chest drainage followed by talc slurry pleurodesis given his high surgical risk. Chest imaging confirmed resolution of the pneumothorax. He was subsequently discharged to a rehabilitation facility; his last arterial blood gas analysis on 3L/min nasal cannula oxygen showed a pH of 7.41, $PaCO_2$ of 55.7 mmHg, PaO_2 of 59 mmHg, and bicarbonate of 32 mmol/L.

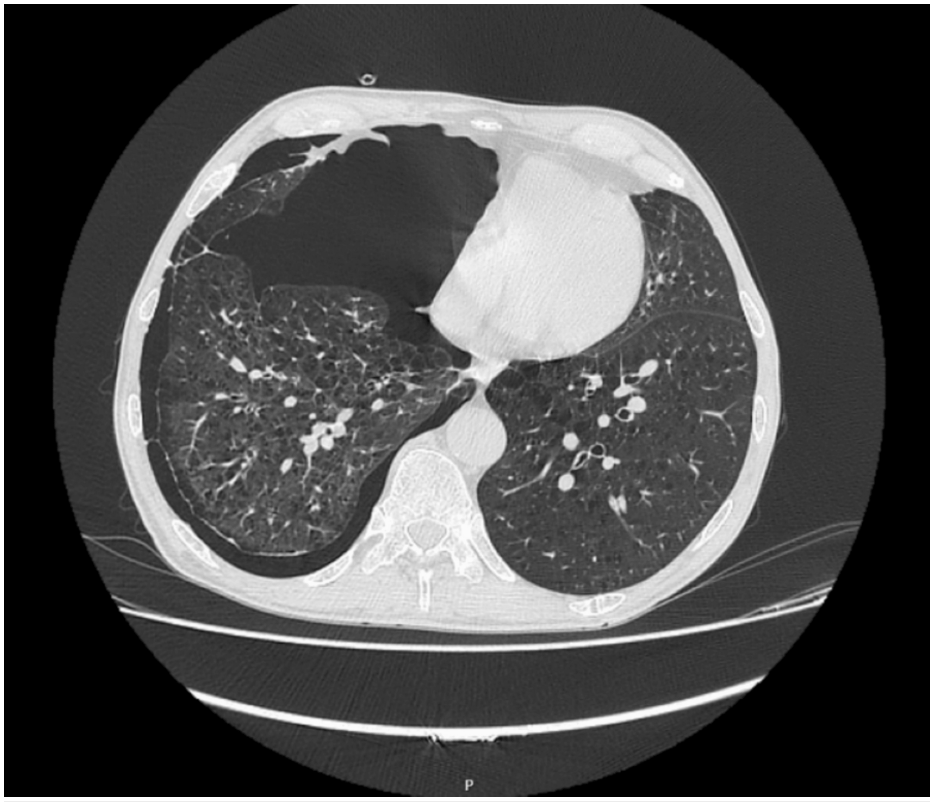


FIGURE 1: Computed tomography of the chest showing advanced destructive emphysema and a large right-sided pneumothorax (maximum pleural separation of approximately 70 mm).

At the time of the current admission, he was receiving long-term home oxygen therapy at 3 L/min. His usual medication included inhaled triple bronchodilator therapy, salbutamol as required, acetylcysteine, pantoprazole, prolonged-release morphine, sertraline, and alprazolam.

The patient presented to the emergency department with a one-day history of abdominal pain predominantly affecting the right abdominal quadrants and nausea. Physical examination revealed rebound tenderness in the right iliac fossa. Laboratory testing showed leukocytosis and elevated C-reactive protein (CRP). Abdominal CT demonstrated a right colonic volvulus with marked distension of the affected segment, reaching a maximum diameter of 10.2 cm (Figure *2*). Areas of reduced mural enhancement were present, raising concern for parietal ischemia and bowel compromise. There was no pneumatosis or pneumoperitoneum. Given the radiological suspicion of ischemia, endoscopic management was deemed inappropriate, and emergency surgery was indicated.

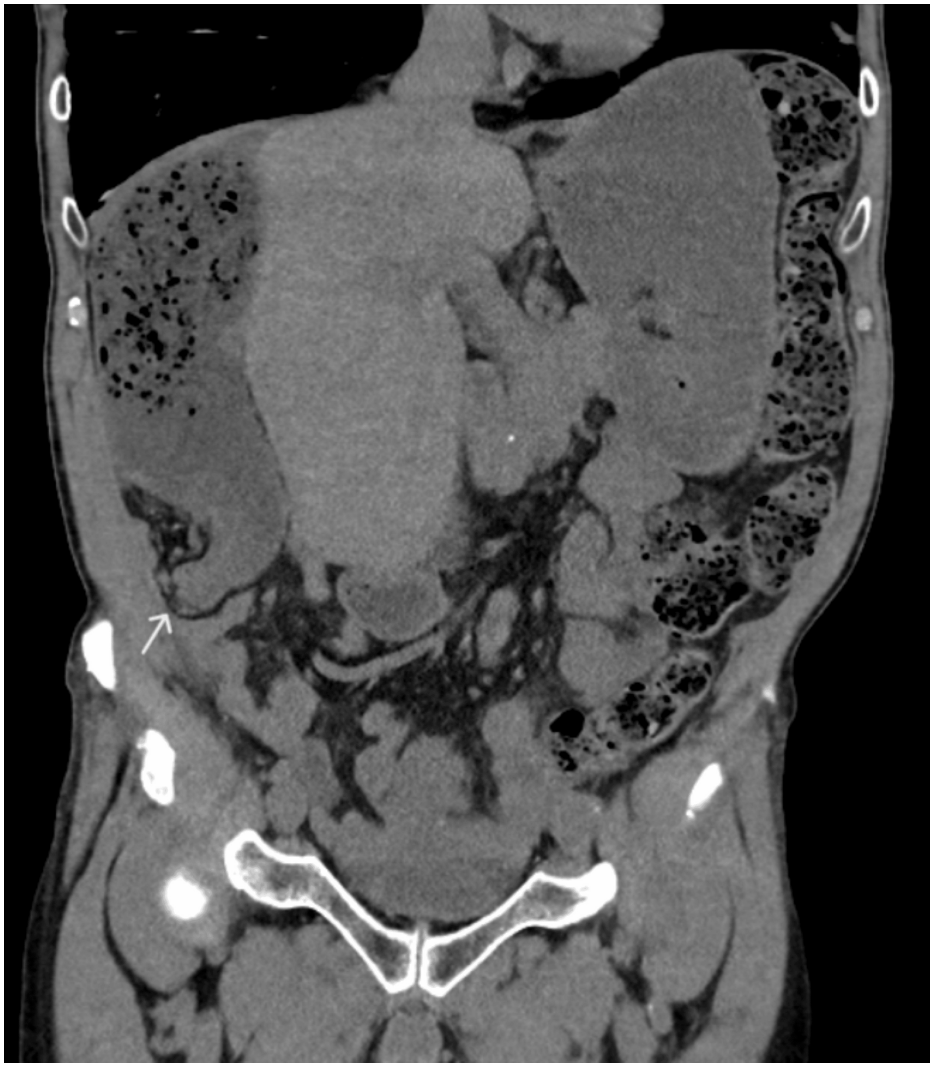


FIGURE 2: Contrast-enhanced computed tomography demonstrating caecal volvulus with marked colonic dilatation (up to 10.2 cm). The torsion point is located at the right iliac fossa (white arrow).

On arrival to the operating room, the patient was markedly cachectic. He was 1.70 m tall, weighed 50 kg, and had a body mass index of 17.3 kg/m². Chest auscultation showed globally reduced breath sounds without wheezing. Preoperative pulse oximetry was 94% on 3 L/min nasal cannula oxygen. There was no hemodynamic instability or new-onset organ dysfunction.

Given the severity of his underlying pulmonary disease, his extremely limited respiratory reserve, and recent pneumothorax, a decision was made to proceed with thoracic epidural anesthesia combined with sedation. An intensive care unit (ICU) bed was requested preoperatively in anticipation of the potential need for invasive ventilatory support should the regional anesthetic technique fail. General anesthesia with endotracheal intubation and positive-pressure ventilation was established as the predefined rescue strategy. Equipment for endotracheal intubation, mechanical ventilation, and immediate chest tube placement was readily available in the operating room.

Standard monitoring followed American Society of Anesthesiologists guidelines [8], including continuous capnography via a nasal cannula with integrated CO_2 sampling. A left radial arterial catheter was placed for invasive blood pressure monitoring and repeated arterial blood gas sampling.

A thoracic epidural catheter was inserted at the T10-T11 interspace. After a test dose, an initial bolus of 12 mL of 0.5% ropivacaine was administered to establish surgical anesthesia, achieving a sensory block up to T4. Additional boluses of approximately 6 mL were administered at approximately 40-minute intervals, for a total intraoperative volume of 30 mL of 0.5% ropivacaine.

Sedation was achieved with a dexmedetomidine infusion without a loading dose at a maximum rate of 1.2 µg/kg/h (total dose approximately 150 µg), supplemented by 10 mg ketamine boluses administered at approximately 45-minute intervals (total dose 40 mg). He remained drowsy but easily arousable to verbal stimulation throughout the procedure.

The patient underwent a three-hour ileocolic resection with primary anastomosis through a midline laparotomy (Figure 3).

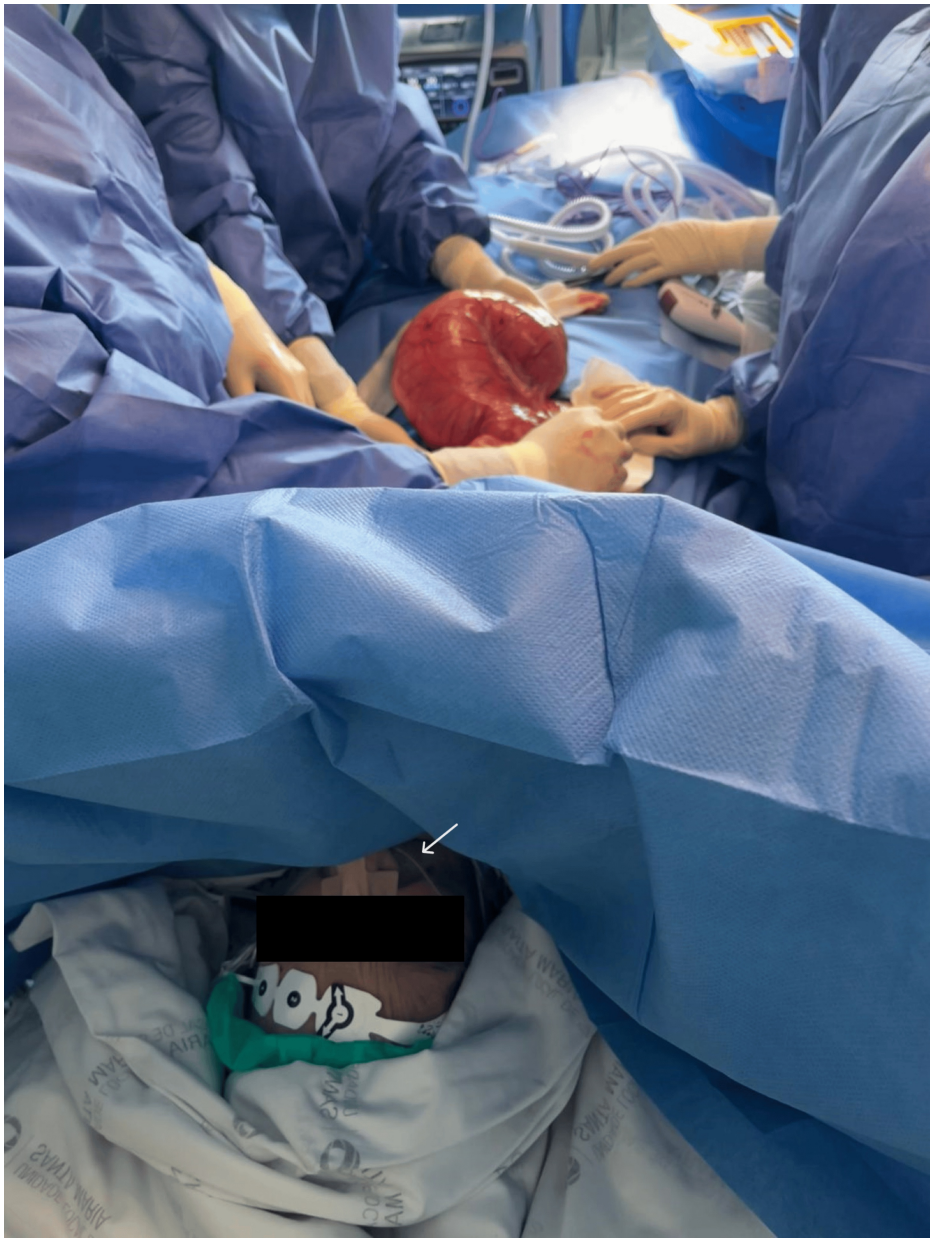


FIGURE 3: Intraoperative view during midline laparotomy showing the markedly distended colon in a patient breathing spontaneously via nasal cannula oxygen (white arrow).

The patient maintained spontaneous breathing throughout the procedure, with a regular and adequate respiratory pattern confirmed by continuous nasal capnography, while receiving supplemental oxygen via nasal cannula at an unchanged flow rate. Oxygen saturation remained stable at approximately 94% on pulse oximetry. The final intraoperative arterial blood gas analysis showed a pH of 7.34, $PaCO_2$ of 47 mmHg, PaO_2 of 75 mmHg, and bicarbonate of 24 mmol/L.

Norepinephrine was administered as required to maintain an adequate mean arterial pressure, with a maximum dose of 0.15 µg/kg/min. Estimated blood loss was approximately 300 mL. The patient received

1500 mL of balanced crystalloid solution, and urine output remained adequate, exceeding 1 mL/kg/h.

He was initially transferred to the post-anesthesia care unit (PACU) for immediate postoperative monitoring. The patient remained stable on supplemental oxygen at 3 L/min. Arterial blood gas values remained comparable to those obtained at the end of surgery. Norepinephrine was rapidly discontinued, with no evidence of hyperlactatemia or inadequate peripheral perfusion. Postoperative epidural analgesia was provided using programmed intermittent epidural boluses (PIEB) of 8 mL administered hourly, combined with patient-controlled epidural analgesia (PCEA) rescue boluses of 6 mL with a 20-minute lockout interval, using 0.2% ropivacaine.

He was subsequently transferred to the surgical ward, where his postoperative recovery was uneventful. The Acute Pain Service reviewed him daily; he remained comfortable and reported no pain at rest. Respiratory status remained stable on his baseline oxygen requirement of 3 L/min. The nasogastric tube was removed on postoperative day one, followed by initiation and progressive advancement of oral intake, which was well tolerated. The epidural catheter and the abdominal drain were removed on postoperative day three, and no relevant postoperative complications or organ dysfunction occurred. He was discharged on postoperative day seven to the same rehabilitation facility for continued respiratory rehabilitation.

Following discharge, the patient reported that the acute illness and subsequent surgery and hospitalization had adversely affected his overall functional status. He stopped smoking but remained significantly functionally impaired, rarely leaving home and experiencing severe dyspnea with minimal exertion, including during activities of daily living such as personal hygiene.

Discussion

Previous case reports support the feasibility of regional anesthesia in selected patients with severe pulmonary disease and recurrent pneumothorax [9]. In one report, a patient with COPD and three previous spontaneous tension pneumothoraces requiring drainage underwent nephrectomy under combined spinal-epidural anesthesia, specifically avoiding general anesthesia and positive-pressure ventilation [10]. However, that case involved elective nephrectomy rather than emergency major abdominal surgery and did not involve a pneumothorax as recent as that in the present patient. Similarly, thoracic epidural anesthesia has been successfully used as the sole anesthetic technique for emergency laparotomy in patients with severe pulmonary disease and bowel ischemia [11]. The present case extends these observations to a patient with advanced bullous COPD and a large spontaneous pneumothorax requiring drainage and pleurodesis only two months before surgery, a combination that has not, to our knowledge, been previously reported.

This case involved exceptionally limited pulmonary reserve. The combination of very severe COPD, extensive destructive emphysema, severe malnutrition, and significant functional limitation placed the patient at particularly high risk of perioperative respiratory morbidity and mortality [1,2]. Importantly, the most recent pneumothorax had occurred only two months before surgery and had required chest drainage followed by talc slurry pleurodesis, making the potential consequences of positive-pressure ventilation an especially relevant consideration. In patients with advanced COPD, positive-pressure ventilation may promote air trapping, dynamic hyperinflation, increased intrathoracic pressure, and hemodynamic compromise [3]. In this patient, the concern was compounded by extensive bullous emphysema [4]. Although the pneumothorax had been treated, this recent event highlighted the fragility of the underlying lung parenchyma. Therefore, avoiding positive-pressure ventilation was a particularly relevant anesthetic goal in this setting.

Thoracic epidural anesthesia provided dense sensory blockade while allowing spontaneous breathing to be maintained. Catheter placement at T10-T11 allowed adequate coverage of the extensive abdominal surgical field, with a sensory level extending to approximately T4. Establishing and maintaining surgical anesthesia required a cumulative ropivacaine dose of 150 mg (3 mg/kg of actual body weight), administered in divided boluses over the three-hour procedure. Given the patient's low body weight and marked cachexia, this dose warranted particular caution, emphasizing the importance of incremental administration and close monitoring for local anesthetic systemic toxicity. Adequate surgical anesthesia was particularly important because pain, anxiety, or inadequate blockade could have increased ventilatory demand and necessitated deeper sedation or conversion to general anesthesia.

The decision to use a regional anesthetic technique required careful preparation for potential failure or deterioration. The predefined rescue strategy was general anesthesia with endotracheal intubation and mechanical ventilation in the event of regional anesthetic failure. The immediate availability of equipment for endotracheal intubation and chest tube placement was particularly important. Thus, avoidance of positive-pressure ventilation was pursued within a predefined safety strategy.

Successful surgery under neuraxial anesthesia also requires careful patient selection and a high degree of patient cooperation. In this case, dexmedetomidine was selected because it provides sedation and anxiolysis with relatively limited respiratory depression compared with many conventional sedative agents [12]. Ketamine was administered in small intermittent doses as an adjunct for analgesia and sedation. This

combination maintained moderate sedation while preserving spontaneous breathing and avoiding positive-pressure ventilatory support.

The intraoperative norepinephrine requirement, reaching 0.15 µg/kg/min, warrants consideration. Epidural-induced sympathetic blockade was considered the most likely contributor, given the extensive block reaching T4 and the volume of local anesthetic required, potentially resulting in arterial and venous vasodilation and reduced venous return. Dexmedetomidine may have further contributed through its sympatholytic effects, despite the absence of bradycardia. Lactate levels remained normal, and no clinical features suggestive of an allergic reaction or anaphylaxis were observed. Although these findings and the rapid postoperative discontinuation of norepinephrine support a predominantly anesthesia-related mechanism, relative hypovolemia and the inflammatory response associated with ischemic bowel could not be excluded as additional contributors.

The postoperative period also required careful consideration. Adequate analgesia is particularly important in patients with severe COPD because uncontrolled abdominal pain may impair diaphragmatic excursion, coughing, secretion clearance, and respiratory mechanics. Conversely, systemic opioid administration may worsen hypoventilation and hypercapnia in susceptible patients [2]. The epidural catheter therefore provided an opioid-sparing analgesic strategy while maintaining patient comfort and allowing respiratory status to remain at baseline oxygen requirements in the intraoperative and postoperative periods.

This case corroborates previous reports that, in carefully selected patients with severe pulmonary disease, neuraxial anesthesia combined with titrated sedation may allow major emergency abdominal surgery to be performed while avoiding tracheal intubation and positive-pressure ventilation. This approach requires an effective neuraxial blockade, patient cooperation, close multidisciplinary planning, continuous monitoring, and immediate access to rescue airway and pleural interventions. In patients with severe bullous COPD and a recent pneumothorax, these considerations may be particularly relevant when the potential consequences of positive-pressure ventilation are substantial.

Conclusions

In a patient with advanced COPD and extremely limited respiratory reserve, emergent major abdominal surgery was successfully performed under thoracic epidural anesthesia combined with dexmedetomidine and ketamine sedation, while avoiding tracheal intubation and positive-pressure ventilation.

This case illustrates that, in carefully selected patients with severe pulmonary disease, neuraxial anesthesia combined with sedative agents that minimally affect respiratory drive may offer a feasible alternative to general anesthesia when the risks of positive-pressure ventilation are particularly high. However, as a single case report, this observation does not establish the general safety or superiority of this approach over general anesthesia. Its use requires careful patient selection, an adequate neuraxial block, patient cooperation, close multidisciplinary planning, continuous monitoring, a predefined rescue strategy for conversion to general anesthesia, and appropriate postoperative critical care resources.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: David G. Paixão, Luísa Lages, Glória Ribeiro, Inês Pereira

Acquisition, analysis, or interpretation of data: David G. Paixão, Alice Nunes Carvalho

Drafting of the manuscript: David G. Paixão, Glória Ribeiro

Critical review of the manuscript for important intellectual content: David G. Paixão, Alice Nunes Carvalho, Luísa Lages, Glória Ribeiro, Inês Pereira

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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