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Original Article

Thoracotomy: An overview of perioperative anesthetic management

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ABSTRACT

Background: The anesthesiologist's role during open thoracotomy includes using a double lumen tube (DLT) for lung isolation, maintaining oxygenation with one-lung ventilation (OLV), and providing postoperative analgesia. This study aims to describe patient demographics, comorbidities, perioperative anesthetic management, complications, and the effectiveness of epidural catheter analgesia.
Methods: In this prospective, observational study, patients who underwent open thoracotomy for decortications were evaluated. Thoracotomy was done under general anaesthesia, OLV with DLT, and epidural analgesia. Postoperatively, all the patients were shifted to the intensive care unit. Collected data included patient demographics, associated co-morbidities, severity of lung diseases, complications, and postoperative recovery. Postoperative analgesia was assessed by the visual analogue scale (0-10).
Result: Of 20 patients, 16 were male, and 4 were female, with a mean age of 35 years (range 15-60) and a mean weight of 52 kg (range 36-66). History of hypertension (N=5), hypertension with diabetes (N=3), obstructive lung disease (N=6), restrictive lung disease (N=11), and both combined (N=3) were noted on pre-anesthetic check-ups. Intraoperative complications were hypotension (N=3), desaturation (N=3), respiratory acidosis (N =7), and metabolic acidosis (N=3). Postoperative analgesia was managed with an epidural catheter (N=18) & systemic analgesia (N=2). All patients had uneventful postoperative courses except one patient who had pulmonary edema and did not survive.
Conclusion: Patients undergoing open thoracotomy had an increased risk for adverse perioperative outcomes. The incidences of perioperative morbidity are high in patients with associated comorbidities. Proper OLV strategy helps to correct intraoperative desaturation. Epidural analgesia plays a key role in postoperative recovery.

Keywords: Chronic empyema, DLT, epidural analgesia, OLV, open thoracotomy

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INTRODUCTION

Empyema thoracis persists as a prevalent thoracic condition, necessitating intricate and sophisticated management protocols.[1] In organized empyema, VATS and open thoracotomy are safe and effective, allowing complete re-expansion of the lung.[2] Open thoracotomy for intrathoracic surgery allows better visualization of the surgical field and lung manipulation with or without intermittent ventilation.[3] Posterolateral thoracotomy is the preferred technique for optimal access to the lung and posterior mediastinal structures.[4]

Thoracic anesthesia presents unique challenges compared to other subspecialties. It involves specialized knowledge in managing one-lung ventilation (OLV) with a double-lumen tube (DLT), ensuring oxygenation, and delivering effective postoperative pain relief to enhance patient safety and surgical outcomes. [5,6,7]

Anesthetic techniques for thoracotomy differ from those used in other major surgeries. Patients require thorough preoperative counseling, history and physical examination, pulmonary function testing, and arterial blood gas analysis. Patients undergoing thoracic surgery are typically high-risk, often elderly, with multiple comorbidities, poor baseline pulmonary function, and compromised physical status due to malnutrition, underlying disease, and the effects of mechanical ventilation, particularly one-lung ventilation (OLV).[3,8,9] A retrospective study by Blank et al. found that during OLV, the majority of patients received high tidal volume. Tidal volume was inversely related to the incidence of respiratory complications and major postoperative morbidity. Currently, there are no standard guidelines for one-lung ventilation (OLV).[9]

Complications of decortication surgery can be air leak and blood loss.[8] Thoracotomy is considered one of the most painful surgical procedures. Forceful retraction of the wound is necessary for better surgical exposure, which places pressure on the intercostal nerves and can lead to acute intercostal neuritis and postoperative pain.[4]

Pain relief enables early tracheal extubation and rapid return to self-ventilation and early mobilization. Adequate analgesia allows coughing and deep breathing, vigorous physiotherapy, and incentive spirometry to prevent atelectasis and secretion retention.[10, 11] Poor analgesia may lead to increased incidences of pulmonary complications in the form of hypoxemia, hypercarbia, atelectasis, pneumonia, and respiratory failure. It has been associated with increased ICU admissions and longer stays in ICU.[4,8] Thoracic epidural analgesia is considered the gold standard for post-thoracotomy pain control, providing continuous analgesia that reduces reliance on parenteral opioids and lowers the incidence of pulmonary complications.[10,11] This study emphasizes perioperative anesthetic management for decortication surgery, covering preoperative evaluation, factors affecting intraoperative anesthesia, postoperative pain management, and any associated complications.

METHODS

This descriptive, prospective, observational study includes twenty patients. The study was conducted after ethical approval (Ref No EC/approval/34/2022/07/03/22), CTRI registration (Ref No CTRI/2022/04/041737), and informed–written consent. Patients underwent pre-anesthetic evaluation one day prior to surgery. Patients of either gender, age more than 15 years, and physical status American Society of Anesthesiologists (ASA) grade III-IV undergoing thoracotomy for lung or pleural lesions were included. Patients having atelectasis with any hematological malignancy, post-chemotherapy or radiotherapy or any solid organ carcinoma, post-organ transplant recipients, history of allergic reactions to local anesthetics, bleeding diathesis, and pre-existing central nervous system or neuromuscular disorders were excluded from the study.

An experienced anesthesiologist gave standard general anesthesia with epidural analgesia. In the operation theatre, an intravenous cannula was secured for fluid and blood transfusion, and radial or dorsalis pedis arterial cannulation for invasive blood pressure (IBP) monitoring and collecting samples for arterial blood gas (ABG) analysis. Monitoring included heart rate, pulse oximetry (SpO_2), non-invasive blood pressure (NIBP), electrocardiography (ECG), invasive blood pressure, $EtCO_2$, and urine output. Intravenous premedication injection of glycopyrrolate (0.4 µg/kg), ondansetron (0.15 mg/kg), and fentanyl (1-2 µg/kg) was given.

Before giving general anesthesia, an epidural catheter 20 gauge was inserted using a Touhy epidural needle 18 Gauge under local anesthesia. The epidural space was located using the loss-of-resistance technique between T7-T8 or T8-T9 intervertebral space in the sitting position under full aseptic precaution. After a test dose with lignocaine 2% plus adrenaline, bupivacaine 0.25 % 8-10 ml was given via the epidural catheter before the start of surgery.

Preoxygenation with 100% oxygen for 3 minutes, and the patient receives intravenous propofol 1-2 mg/kg anesthesia induction. Injection of xylocarp 1.5 mg/kg was administered to suppress stress response and to prevent propofol injection pain. Tracheal intubation using succinylcholine 2 mg/kg as muscle relaxant. Intubation was done with a proper size double lumen tube (DLT) size 35 for females and 37, 39 for males. Proper placement of DLT was confirmed by the auscultation method.

Mechanical ventilation was set in volume-controlled ventilation (VCV): tidal volume 5-6 ml/kg, respiratory rate 14 breaths/minute, oxygen inspiratory fraction 0.5, and positive end-expiratory pressure 5 cm of H_2O. During OLV, VCV continues with a tidal volume of 3-4 ml/kg and a respiratory rate of 16-18 breaths/minute.

Mechanical ventilation was adjusted to achieve the lowest driving pressure while maintaining satisfactory SpO_2 levels (94-95%). Two cycling recruitment maneuvers were applied at the onset and conclusion of one-lung ventilation (OLV). Anesthesia was maintained with sevoflurane (0.6-2.0%) or desflurane (2-6%), in a mixture of 50% oxygen and 50% air, along with an initial bolus dose of atracurium (0.5 mg/kg) followed by incremental doses of 0.1 mg/kg. After giving the lateral position for surgery, the position of DLT was again checked by auscultation. Intraoperative normal saline, ringer lactate, whole blood, and products were transfused. Perioperative hemodynamic parameters, ABG analysis reports, and any complications were recorded.

Before closing the chest, bronchial suture lines and lung surfaces were tested for air leaks by manually giving positive pressure ventilation of approximately 25 cmH_2O. After regaining spontaneous breathing, the reversal of neuromuscular block was done with neostigmine 0.05mg/kg and glycopyrrolate 0.8µg/kg. Assisted /controlled ventilation continued until the patient had adequate tidal volume and respiratory rate, SpO_2 >95%, and was hemodynamically stable. Thereafter, tracheal extubation was done. All patients were shifted to the intensive care unit (ICU) for 24-48 hours of observation. Postoperative pain was assessed with a visual analogue scale (VAS) of 0-10. For analgesia, bupivacaine 0.125% 8 ml with tramadol 1 mg/kg was given when VAS ≥ 4 for 24 hours and thereafter tramadol 1 mg/kg 6ml for 72 hours. The epidural catheter was removed on the 3rd postoperative day. Systemic analgesia inj. Tramadol 2mg/kg was given in two patients.

Intraoperative complications hypotension corrected with intravenous (IV) colloids, blood transfusion, and, if required, administration of noradrenaline infusion. Intermittent ventilation of both lungs was done when desaturation was seen with OLV. Respiratory rate 20-22 was set for respiratory acidosis, and metabolic acidosis was corrected with inj. Sodium bicarbonate 7.5%. Demographic data was collected from the patient's medical records. Duration of surgery (time from initiation of surgery to end of surgery), duration of anesthesia (time from induction of anesthesia to time neuromuscular reversal), and recovery time (time from extubation to postoperative Aldrete score >9) were also recorded.

The data was analyzed using Microsoft Office Excel 2010. The quantitative data were displayed using the mean and range, and categorical data were displayed in frequencies and percentages.

RESULT

Twenty adult patients were taken for open thoracotomy for decortication. **Table 1** shows demographic parameters: age, gender, weight, ASA physical status, site of arterial cannulation, mean duration of surgery, and anesthesia.

Table 1. Demographic characteristic, duration of surgery and anaesthesia

Variables	Number=20
Mean Age in years (range)	35 (15-60)
Gender (male/female) (%)	16/4 (80:20)
Mean weight in kg (range)	50 (36-66)
ASA physical status III/IV (%)	4/16 (20:80)
Arterial cannulation (radial /dorsalis pedis)	18/2 (90:10)
Mean duration of surgery (min) (range)	205 (180-240)
Mean duration of anaesthesia (min) (range)	236 (195-255)

Empyema due to different causes and computerized tomography (CT)/ magnetic resonance imaging (MRI) findings are shown in **Table 2.**

Table 2. Clinical diagnosis and CT/MRI findings

Causes of Empyema	CT Scan /MRI findings	No = 20 (%)
Pneumonia	Left lung collapse	9 (45%)
Intrapleural rupture of liver abscess	Intrapleural rupture of liver abscess with right lung atelectasis	3 (15%)
Rupture hydatid cyst	Right Lung atelectasis/Collapse	3 (15%)
Trauma (Pyo-pneumothroax)	Partial or full collapse of left lung	5 (25%)

The number of patients with associated co-morbidities is shown in **Table 3.**

Table 3. Associated co-morbidities

Co-morbidities	No = 20 (%)
Hypertension	05 (25%)
Hypertension and diabetes	03 (15%)
Obstructive lung disease	06 (30%)
Restrictive lung disease	11 (55%)
Combine obstructive + restrictive lung disease	03 (15%)
FEV1 (% predicted)	
Mild >70%	03 (15%)
Moderate 50-69	15 (75%)
Severe 35-49	02 (10%)

FEV1 : forced expiratory volume in one second

The correlation of FEV1 % predicted with intraoperative complications and recovery time is shown in **Table 4.** Higher incidence of intraoperative hypotension, desaturation, respiratory acidosis, and metabolic acidosis were present in patients having FEV1 <70% predicted. One patient having FEV1 <50% predicted had intraoperative and postoperative hypotension, desaturation, and metabolic acidosis with an Aldrete postoperative score of four. She was shifted to the ICU for mechanical ventilator support. Later, she developed pulmonary edema, did not respond to treatment, and was declared dead.

Table 4. Correlation FEV1 % predicted and peri-operative complications and recovery time

FEV1 (% predicted)	No (%)	Complications	No (%)	Recovery time (Minutes)
Mild >70%	03 (15%)	Hypotension	01 (5%)	10
Moderate 50-69%	15 (75%)	Hypotension Desaturation Respiratory acidosis Metabolic acidosis	01 (5%) 01 (5%) 03 (15%) 01 (5%)	20
Severe 35-49%	02 (10%)	Hypotension Desaturation Respiratory acidosis Metabolic acidosis Postop. Aldrete score 4	01 (5%) 02 (10%) 04 (20%) 02 (10%) 01 (5%)	>30 Expired

Postoperative pain was assessed with a VAS of 0-10. For analgesia, the first dose of inj. bupivacaine 0.125% 8 ml with tramadol 1 mg/kg was given when VAS ≥ 4 and repeated after 8-10 hours for 24 hours and thereafter bolus of tramadol 1 mg/kg in 6ml saline was given 8 hourly for 72 hours.

Total consumption of epidural analgesia is shown in **Table 5.** Epidural catheter was removed on 3rd postoperative day. Systemic analgesia inj. Tramadol 2mg/kg was given in two patients.

Table 5. Postoperative epidural analgesia

Postoperative hours	Total dose of inj. Bupivacaine 0.125%	Total dose of inj. Tramadol	No (%)
First 24 hours	37.5 mg 37.5 mg	150 mg 100 mg	13 (72.2) 05 (27.7)
Second 24 hours	--	150 mg 100 mg	08 (44.4) 10 (55.5)
Third 24 hours	--	100 mg	18 (100)

DISCUSSION

Empyema thoracis is a common thoracic issue that, if untreated, progresses to a chronic phase, forming an empyema cavity and causing pleural fibrosis, which limits lung re-expansion. Decortication is a safe and effective treatment, and both VATS and open thoracotomy can successfully allow full lung re-expansion.[1,2,12]

Open thoracotomy for intrathoracic surgery allows better visualization of the surgical field and lung manipulation with or without intermittent ventilation.[3] It also allows a more rapid recovery with fewer chest tube days and decreased length of hospital stay. Rai et al. reported a 95-100% success rate for decortication.[2]

A total of 20 patients having empyema due to pneumonia, ruptured liver abscess, ruptured hydatid cyst, and post-trauma pyopneumothorax underwent open thoracotomy for decortication. The mean age was 35, and the mean weight was 50kg. On preoperative evaluation, five patients had hypertension, three patients had hypertension and diabetes, six patients had obstructive lung disease, three restrictive lung diseases, and three combined obstructive and restrictive lung diseases. The anesthetic management for thoracotomy is always a great challenge due to pre-existing pulmonary disease. These challenges increase because of the open thoracic cavity, surgery in the lateral position, thoracic organ manipulations, risk of major bleeding, and one-lung ventilation with the requirement of lung isolation. The most frequent risk factors include age ≥ 75 years, BMI ≥ 30 kg/m^2, ASA classification ≥ 3, cardiovascular comorbidity, preoperative pulmonary function tests, chronic obstructive pulmonary disease, and smoking status.[3,8,13] Perioperative assessment of respiratory functions, including lung mechanics, pulmonary parenchymal function, and cardiopulmonary reserve, is crucial for better management and outcomes.[14,15]

Thoracotomy was done under general anesthesia with OLV using a DLT and epidural analgesia. Anesthesia was induced with propofol and succinylcholine, followed by endobronchial intubation. Sevoflurane or desflurane was used for maintenance. During apnea, manual ventilation with the Bain circuit, small tidal volumes, low inspiratory pressures, and prolonged expiratory phases was employed to prevent hypoxemia and hypotension.[16] Sevoflurane increases bronchodilatation and decreases incidences of acute lung injury by inhibiting the release of proinflammatory mediators during OLV and lung resection.[3] In the operation theatre, ECG, NIBP, IBP, SpO_2, $EtCO_2$, and urine output were monitored. Intraoperatively, along with standard non-invasive monitoring, arterial lines are indicated to measure blood pressure and arterial blood gas determination.[3]

Intubation was done with a proper size double-lumen tube size of 35 for females and 37 and 39 for males. Proper placement of DLT was confirmed by the auscultation method. After giving lateral position for surgery, the position of DLT was checked by auscultation, and reinsertion or repositioning of DLT was done in four patients. Postoperatively, one patient was shifted to the ICU for mechanical ventilatory support after exchanging DLT with a lumen endotracheal tube. During thoracotomy, double-lumen tubes (DLT) provide better lung isolation, allowing for optimal surgical exposure, especially when one lung is contaminated. However, DLT insertion requires more skill and time, and postoperatively, it must be replaced with a simpler endotracheal tube, which can be challenging. This process is associated with a higher risk of airway injuries, including hoarseness, vocal cord damage, and tracheal or esophageal injury.[3]

In all the patients, proper placement of DLT was confirmed by chest auscultation method after intubation and in lateral position for thoracotomy. It is very common to inadvertently intubate the right mainstem while trying to intubate the left mainstem due to the steeper angle of the right mainstem bronchus.[5] Fiber-optic bronchoscopy has emerged as the standard approach for ensuring accurate positioning and ongoing maintenance of lung isolation devices. Intraoperative fatal complications can occur due to the malposition of lung isolation devices.[5] S. Inoue et al. found that DLT malposition can happen repeatedly in a lateral position during OLV and, if not corrected, can lead to hypoxemia.[17] DLT for left bronchial intubation under guidance of fiberoptic bronchoscope (FOB) reduces the incidence of tube malpositioning.[18] Hypoxemia can occur due to the double-lumen tube (DLT) misplacement in the lateral position. Patients with a history of prior thoracotomy are particularly prone to hypoxemia during one-lung ventilation (OLV) due to the potential malpositioning of the DLT.[17] Anesthesia maintenance was achieved using sevoflurane (0.6-2.0%) or desflurane (2-6%) combined with a gas mixture of 50% oxygen and 50% air. Additionally, a bolus dose of intravenous atracurium at 0.5 mg/kg was administered, followed by incremental doses of 0.1 mg/kg as needed. Intraoperative normal saline, ringer lactate, colloids, whole blood, and products were transfused. Perioperative hemodynamic parameters, ABG analysis reports, and any complications were recorded. One-lung ventilation (OLV) protects the unaffected lung from contamination by pus or blood from the affected lung, allows differential lung ventilation to minimize volutrauma and barotrauma, and optimizes ventilation to the unaffected lung. Additionally, OLV enhances visualization of the operative site.[3,5,17] In thoracotomy, the deliberate collapse of the lung creates a calm surgical environment. A fully collapsed lung requires less forceful retraction by the surgeon. This minimizes intraoperative lung trauma, leading to improved gas exchange both during and after the procedure. Selective lung collapse enhances surgical conditions and shortens operative times for pulmonary procedures.[6]

Intraoperative complications were desaturation corrected by intermittent total lung ventilation, PEEP of five, and checking position of DLT, metabolic acidosis corrected by intravenous Sodium bicarbonate and respiratory acidosis are corrected by increasing respiratory rate, hypotension is corrected, and colloids and whole blood transfusion are corrected. In correlation with preoperative FEV1 % predicted, incidences of intraoperative complications hypotension, desaturation, and acidosis were higher in patients having FEV1 % predicted <70%. One female patient having preoperative FEV1 <50% predicted intraoperative desaturation and hypotension. Her postoperative Aldrete recovery score was four. She was shifted to the ICU for mechanical ventilator support. Later she developed pulmonary oedema which did not respond to the medical line of treatment, and not survive. During the procedure, intraoperative oxygen saturation can be enhanced by periodically reinstating two-lung ventilation (TLV), raising the inspired fraction of oxygen, verifying and adjusting the position of the double-lumen tube (DLT), reducing the concentration of inhalational agents, or initiating vasopressors or inotropes to enhance cardiac output.[3]

Applying positive end-expiratory pressure (PEEP) to the dependent lung and/or continuous positive airway pressure (CPAP) to the operative lung helps maintain oxygen saturation during OLV. Hypoxemia is a major concern due to lung function changes.[3,19] gas exchanges can be affected by OLV. In the lateral decubitus position during thoracotomy, gravity predominantly directs blood flow to the dependent lung, while ventilation initially favors the operative lung due to reduced compliance in the dependent lung. Collapsing the operative lung with one-lung ventilation (OLV) helps manage this by utilizing hypoxic pulmonary vasoconstriction (HPV). HPV leads to a time-dependent reduction in blood flow to the poorly ventilated operative lung, thereby improving the ventilation/perfusion (V/Q) mismatch.[3]

Due to reducing functional residual capacity (FRC), general anesthesia increases airway resistance. During thoracic surgery, airway resistance may increase further due to obstruction with secretions and bronchospasm. Associated medical conditions can also change airway caliber and reactivity. Intubation with DLT can cause bronchoconstriction due to direct stimulation of mucosa. Propofol does not release histamine, and it does not produce bronchospasm. So, it should be considered an induction agent in reactive airway disease patients.[20]

Intravenous propofol causes peripheral vasodilatation but does not inhibit hypoxic pulmonary vasoconstriction (HPV). [21] While using inhalational anesthesia with sevoflurane at 1 MAC, there would be a reduction of the HPV response by approximately 25%. Ventilation-perfusion mismatch is common in lung surgery. Sevoflurane can improve ventilation distribution in the dependent lung during one-lung ventilation (OLV), potentially reducing shunt. Its bronchodilatory properties and rapid emergence capabilities support early recovery of spontaneous breathing, reducing the need for postoperative mechanical ventilation.[22]

Lung-protective ventilation mitigates one-lung ventilation (OLV)-related lung injury. Early acute lung injury (ALI) may arise from high intraoperative ventilation pressures, prolonged surgery, excessive IV fluids, and pneumonectomy. Late ALI (3-10 days post-surgery) can result from bronchopneumonia or aspiration.[23] In a retrospective study by Blank et al., it was found that during one-lung ventilation (OLV), most patients received high tidal volumes. The study observed an inverse relationship between tidal volume and the occurrence of respiratory complications and major postoperative morbidity. Currently, there are no standard guidelines for OLV.[9] High tidal volume and low tidal volume without adequate positive end-expiratory pressure (PEEP) can be harmful, especially in high-risk patients. Slinger et al. recommended protective ventilation strategies involving low tidal volumes and PEEP. Extended periods under general anesthesia increase the likelihood of postoperative lung issues, including decreased surfactant production, heightened permeability between alveoli and capillaries, impaired alveolar macrophage function, and slowed mucociliary clearance, all of which can hinder gas exchange.

Positioning and mechanical ventilation are major contributors to postoperative atelectasis in as many as 90% of patients, resulting in ventilation-perfusion (V/Q) mismatch, reduced lung compliance, and hypoxemia. In addition to providing analgesia, inducing unconsciousness, maintaining stable hemodynamics, and implementing single-lung ventilation as needed, anesthesiologists aim to minimize ventilator-associated lung injury (ALI).[3,24,25,26] For postoperative pain management, thoracic epidural catheter placement was done between T7-T8 or T8-T9 intervertebral space, in sitting position via midline approach. Extradural catheter placement in the seated conscious patient before induction of anesthesia via midline or paramedian technique is a preferred method. [27] Thoracic epidural is superior to lumbar epidural analgesia. However, thoracic catheter insertion becomes technically difficult due to caudally angulated thoracic spinous processes. [28] Epidural bolus dose of bupivacaine 0.25%, 8-10 ml was given in eighteen patients before the surgery. At the end of the surgery, a repeat dose with a combination of Bupivacaine 0.125% with tramadol 1mg/kg total volume 8ml was given and repeated when VAS ≥ 4. Tramadol 1mg/kg 6 ml was given 8 hours for the next 72 hours. In all these patients, VAS remains < 4. Two patients receiving systemic opioids for analgesia may benefit from epidural administration of local anesthetic, opioids, or a combination of both. This approach optimizes their synergistic effects, allowing for reduced individual doses and potential side effects. [29]

Continuous thoracic epidural analgesia (TEA) remains the preferred method for managing post-thoracotomy pain due to its superior effectiveness in providing pain relief both at rest and during movement, leading to high patient satisfaction. TEA reduces the need for rescue analgesics and systemic opioids, thereby potentially lowering the incidence of pulmonary complications. Complications associated with TEA include hypotension, bradycardia, urinary retention, incomplete or failed nerve blocks, neurological injury, and rarely, paraplegia from epidural hematoma. Opioids are crucial in treatment protocols and can be administered via various routes, with intravenous patient-controlled analgesia (IV PCA) being a commonly used method due to its simplicity and effectiveness..[6, 30]

In their systematic review, Joshi et al. found that thoracic epidural analgesia (TEA) using local anesthetic (LA) combined with opioids like fentanyl, sufentanil, or morphine, LA alone, or a lipophilic opioid alone (e.g., fentanyl), significantly reduced postoperative pain scores and the need for additional pain relief compared to systemic opioid analgesia for up to three days after surgery. The use of epidural hydrophilic opioids (e.g., morphine) showed varied effects on pain intensity and analgesic requirements compared to systemic opioids (e.g., morphine, nicomorphine, or tramadol). TEA with LA plus opioids was associated with a higher incidence of low blood pressure compared to systemic opioid analgesia. However, there was no significant difference in the occurrence of lung complications between the TEA and systemic opioid groups.[31]

Post-thoracotomy pain ranks among the most severe of all surgical procedures. Factors contributing to this pain include surgical retraction, tissue resection, dislocation of costovertebral joints, incidental rib fractures, and injury to intercostal nerves. Pleuritic pain from chest tubes and shoulder discomfort due to lateral positioning can further exacerbate the pain. Severe postoperative pain can lead to reduced respiratory effort and functional residual capacity, impairing the ability to cough and clear secretions. This can result in airway closure, atelectasis, ventilation-perfusion mismatch, tissue hypoxemia, hypercapnia, and potentially respiratory failure, especially in patients with underlying lung conditions. Acute pain also increases myocardial oxygen demand, afterload, and the risk of myocardial dysfunction and arrhythmias, necessitating ICU admissions and prolonged stays.Drawbacks of thoracic epidural analgesia include technical challenges and a failure rate of up to 15%. Bilateral sympathetic blockade from epidural anesthesia may cause hypotension, which is another consideration in its use.[3 4]

Pain relief after thoracotomy enables early tracheal extubation and rapid return to self-ventilation and early mobilization. Adequate analgesia allows coughing and deep breathing, vigorous physiotherapy, and incentive spirometry to prevent atelectasis and secretion retention.[4] Epidural analgesia is regarded as the gold standard modality for post-thoracotomy pain. [32] Intraoperatively, high ventilation pressure was observed in one patient during decortication surgery. Postoperatively, she developed pulmonary edema and required mechanical ventilator support.

During thoracotomy, arterial oxygenation is affected by changes in cardiac output. Reduction in cardiac output occurs because of the use of high inflation pressures and application of PEEP to the dependent lung, as well as hypovolemia resulting from blood loss/fluid depletion.[33] Intravenous crystalloid, pack cell, and fresh frozen plasma were administered as per loss. Three patients developed hypotension and required ionotropic (noradrenaline infusion) support. Before scheduled procedures, preoperative assessment focuses on stabilizing lung disease, optimizing lung function, promoting smoking cessation, and initiating early respiratory physiotherapy. Patients with lung disease often have additional health conditions, necessitating evaluation for risks such as cardiovascular, metabolic, renal issues, and venous thromboembolism during the perioperative phase. Extended exposure to general anesthetics may reduce surfactant production, increase alveolar-capillary permeability, impair alveolar macrophage function, and slow mucociliary clearance, leading to disturbances in gas exchange. Postoperative atelectasis in many patients is mainly due to positioning and mechanical ventilation.[26] Seventeen patients had FEV1 levels below 70% of predicted, with two having FEV1 levels below 50%. One of these patients developed postoperative pulmonary edema.

In our study, open thoracotomy for decortication was done with one-lung ventilation using a double lumen tube and providing postoperative pain relief with an epidural catheter to improve patient safety and surgical outcomes. Intraoperative OLV was done with low tidal volume and PEEP. Intraoperative complications were observed in patients with associated co-morbidities. Functional results were excellent as all patients returned to their normal activities before surgery except for one mortality. One limitation of this article is the use of intermittent bolus doses of epidural tramadol for postoperative analgesia. So, we can recommend continuous epidural analgesic infusion.

CONCLUSION

Open thoracotomy and decortications is a standard treatment of chronic empyema. The perioperative complication rate was high in adult patients with associated comorbidities. Initiation of OLV is associated with a fall in PaO_2. Due to the proper placement of DLT and adjusting the ventilator setting, the incidence of hypoxia was low. Thoracic epidural anesthesia/ analgesia should be added to the standard protocol for patients undergoing open thoracotomy for decortications. It reduces the stress response, improves postoperative analgesia, and shortens ICU stay.

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CONFLICT OF INTEREST

The author declares there is no conflict of interest.

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