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Case Report

Anaesthesia Section

An Intricate Case of Pyopneumothorax with Trapped Right Lung Requiring Swift Adaptation and Multidisciplinary Collaboration

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ABSTRACT

Pulmonary Tuberculosis (PTB) is a significant cause of morbidity, especially in patients with underlying health conditions. The present case highlights the complex management in a patient with intricate medical history, marked by tuberculosis, multiple Intercostal Chest Drain (ICD) procedures, and pyopneumothorax with long-standing diabetes mellitus and a history of smoking, adding to the uniqueness of the case. The authors present a case of a 67-year-old male, admitted for a right Pneumonectomy (PE) due to a complex combination of pyopneumothorax, right trapped lung and post-decortication status. However, due to the fragile nature of the tissue and the existence of vascular adhesions, it was decided to choose "physiological lung exclusion" by separating the affected lung from the tracheobronchial tree by cutting the bronchus and tying off the pulmonary artery, without removing any lung tissue, while keeping the pulmonary veins intact. The present report highlights the challenges faced, the multidisciplinary approach employed, and the successful surgical outcome, underscoring the importance of collaborative management.

Keywords: Decortication, Double lumen tube, Pneumonectomy, Pneumothorax, Pulmonary tuberculosis

CASE REPORT

A 67-year-old male, 158 cm in height and weighing 60 kg, presented with persistent cough and pain at the Intercostal Chest Drain (ICD) site for three months. The pain, described as dull, constant, non radiating, and increased in severity with inspiration, was partially relieved by Tablet Paracetamol 500 mg and Tablet Diclofenac 75 mg as needed. Importantly, there was no history of trauma, breathlessness, fever, loss of appetite, or weight loss at the time of initial presentation. The patient was a known case of Diabetes Mellitus Type-2 since 20 years, on Tablet Metformin 500 mg twice daily, Tab Glimepiride 1 mg once daily, Tab Vildagliptin 50 mg once daily for glycaemic control.

The patient was admitted with symptoms of breathlessness, fever (39.8°C), and cough. Initial investigations and High-resolution Computed Tomography (HRCT) of the chest revealed a large hydropneumothorax in the right hemithorax, resulting in complete collapse of the right lung. Subsequent evaluation led to the diagnosis of pleural tuberculosis, and an ICD was inserted. The patient initiated the Isoniazid+Rifampicin+Pyrazinamide+Etham butol (HRZE) regime for six months, with a pleural fluid negative smear. However, pleural fluid GeneXpert (CBNAAT) testing after six months indicated resistant tuberculosis, suggesting treatment failure. Consequently, the patient was reinitiated on Anti-tubercular Treatment (ATT), and therapeutic thoracocentesis was performed, draining 1300 cc of thick, straw coloured pus. Later the patient also developed an abscess (82×17×9 mm) at the ICD site. Moderate to gross right pleural effusion with pleural thickening and a subcutaneous plane hypodense collection, indicative of empyema with abscess formation was seen in HRCT thorax.

The patient was admitted under respiratory medicine with an initial diagnosis of a trapped right lung associated with a resolving pyopneumothorax and failed post-decortication status {Post-operative Day (POD) 38}. The patient's treatment regimen comprised i.v. Meropenem 1 g three times daily, i.v. Metronidazole 500 mg three times daily, i.v. Cotrimoxazole 2960/592 mg once daily, and continuation of HRZE therapy.

Upon examination, the patient was in fair general condition and afebrile, with a blood pressure of 120/90 mmHg, a heart rate of 94 bpm, and oxygen saturation of 95% on room air. Cardiovascular examination revealed normal heart sounds without murmurs. Respiratory examination indicated reduced air entry, especially on the right-side, along with coarse crepitations bilaterally in the lower zone and diffuse rhonchi.

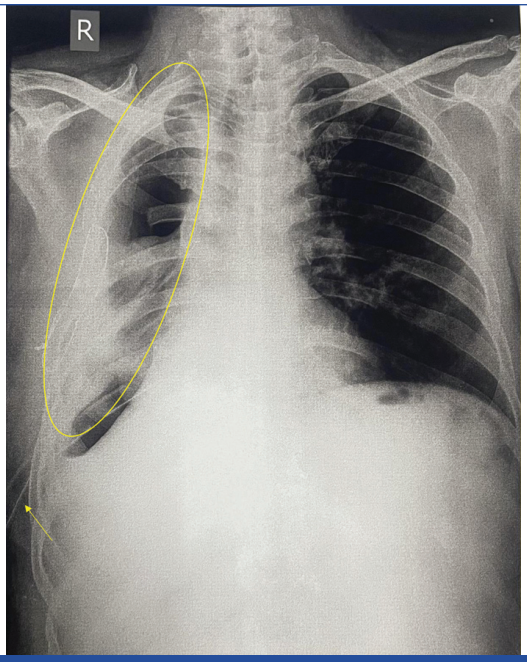
Throughout his medical history, the patient underwent multiple ICD insertions (total of three) and ICD repositioning (total of two), along with frequent thoracocentesis procedures. The patient received ATT for two years, discontinuing the treatment two months before the surgery. Bronchoscopy and Broncho Alveolar Lavage (BAL) were performed for decortication. Unfortunately, post-decortication, the right lung did not fully expand because of extensive dense fibrosis due to past history of multiple instrumentations and the patient complained of breathlessness on exertion and pain, necessitating admission for further management.

The patient had a history of cigarette smoking (20 Pack Years) with a severe smoking index of 400. Recent blood sugar monitoring indicated readings within the normal range with Glycated Haemoglobin (HbA1c) of 7.5%. The patient remained in a post-decortication status, and a right ICD was *in situ* for three months.

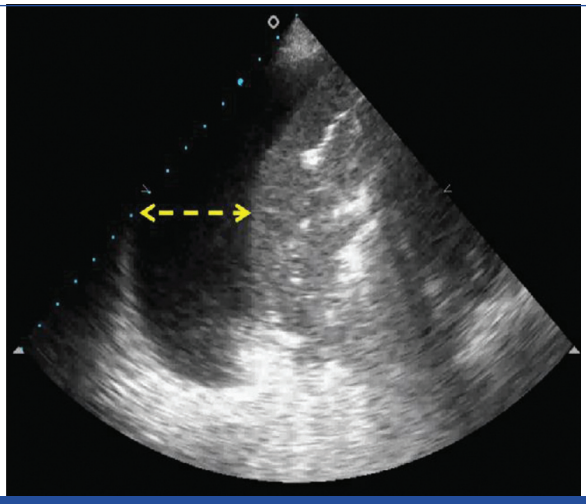
Preoperative blood investigations were within normal limits, and Electrocardiogram (ECG) showed normal sinus rhythm. Recent chest X-ray displayed a collapsed right lung alongside left hilar lymphadenopathy, with the right ICD *in situ* [Table/Fig-1]. Ultrasonography (USG) of the thorax demonstrated a mild pleural effusion on the right-side, measuring 100-150 cc, along with a hypoechoic accumulation measuring 3.9×1.7×4.3 cm, approximately 8 cc in volume, in the infrascapular region on the right [Table/Fig-2].

High-resolution Computed Tomography (HRCT) of the thorax revealed the presence of the right ICD through the 8th and 9th intercostal spaces and a large pyopneumothorax leading to near-complete collapse of the right lung with ipsilateral tracheal and mediastinal shift [Table/Fig-3,4].

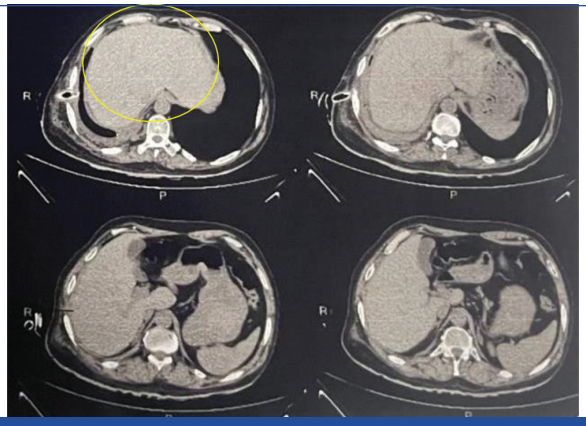
At arrival in the operating room, standard monitoring devices like BP cuff, 5 Lead ECG, temperature and SpO_2 probe were connected. A 16G peripheral intravenous cannula was secured on the left hand. An epidural catheter (Portex-Smiths Medical®) was placed using loss of



[Table/Fig-1]: Preoperative chest X-Ray showing right collapsed lung (yellow circle) and right ICD in-situ (yellow arrow).

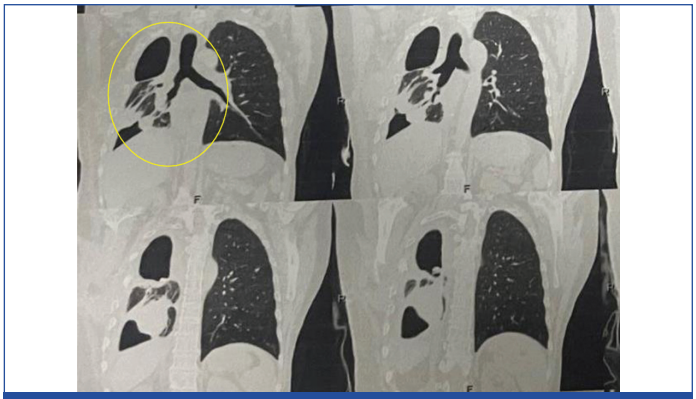


[Table/Fig-2]: USG thorax showing mild right pleural effusion (yellow dashed line).



[Table/Fig-3]: Preoperative axial HRCT 1/2 showing large right pyopneumothorax.

resistance technique in the T4-T5 interspace in sitting position using 18G Touhy's epidural needle and after confirming epidural catheter placement by positive Meniscus sign, Inj. Bupivacaine 0.5% 10 cc with 3 mg Morphine was given in intermittent doses for adequate intraoperative and postoperative analgesia and haemodynamic stability. An infusion of 0.25% Bupivacaine (0.1 mL/kg/hour) was started subsequently. A 7-Fr triple-lumen central venous catheter (Centro-Romsons®) was inserted into the right internal jugular vein, and the left radial artery was cannulated and baseline Arterial Blood Gas (ABG) analysis was done.



[Table/Fig-4]: Preoperative coronal HRCT 2/2 showing right tracheal and mediastinal shift with loss of right lung volume.

Prior to the induction, the patient received 100% oxygenation for three minutes. General anaesthesia induction consisted of i.v. Propofol (2 mg/kg), Fentanyl (2 mcg/kg), and Vecuronium (0.1 mg/kg). Orotracheal intubation was performed using a 37F left-sided Robertshaw Double-Lumen Tube (DLT) and fixed at 27 cm mark to facilitate left-sided One-Lung Ventilation (OLV) and to isolate the right lung preventing further lung trauma during ventilation and infection or secretions from entering the left lung. Following the observation of chest rise with ventilation and the presence of End-Tidal CO_2 ($EtCO_2$), bilateral and then left-side unilateral breath sounds were auscultated. Tube placement was confirmed, and the patient was positioned in the left lateral decubitus position. Ventilator was adjusted to a Tidal Volume (TV) of 6-8 mL/kg and a Respiratory Rate (RR) adjusted to maintain normal $EtCO_2$. During OLV, TV was decreased to 3-5 mL/kg and RR increased to maintain Minute Ventilation (MV). Peak airway pressure ranged between 18-21 cm H_2O during OLV.

Maintenance was with a low-flow mixture of oxygen, isoflurane (MAC of 1.2), and air. Intraoperative, dense adhesions were encountered between the lung and chest wall. The right main stem bronchus was found to be transected, with a 4 cm gap between the two segments. Given the tissue's friability and the presence of vascular adhesions, a decision was made to opt for physiological lung exclusion. Despite a blood loss of one litre, the patient maintained haemodynamic stability, supported by infusion of Noradrenaline (2 mg in 50 cc) @ 0.05 to 0.1 mcg/kg/min. Intravenous fluid therapy consisted of 1000 mL Gelofusine and 500 mL of Ringer's Lactate, with the goal of achieving a urine output of 0.5-1 mL/kg/hour and Central Venous Pressure (CVP) monitoring (8-10 mmHg) during the 4-hours of surgery.

Following surgery, the patient was reversed using Neostigmine 0.05 mg/kg and Glycopyrrolate 0.008 mg/kg. The patient was successfully extubated demonstrating no immediate post-extubation complications. The patient was pain-free with stable vital signs [Table/Fig-5] and was subsequently transferred to the Intensive Care Unit (ICU) with supplemental oxygen @ 6 L/min via O_2

[Table/Fig-5]: Postoperative vitals of the patient.

face mask. Postoperative analgesia was continued through infusion of 0.25% Bupivacaine @ 0.1 mL/kg/hour.

DISCUSSION

Pulmonary Tuberculosis (PTB) remains prevalent in developing nations such as India. As the disease progresses over time, it leads to extensive damage in lung tissue, resulting in significant fibrosis, calcification, and the development of vascular adhesions between the lung and the chest wall [1]. The build-up of dense fibrous tissue within the pleural cavity can become so extensive that it hinders the expansion of the underlying lung, necessitating corrective intervention [2]. In cases where all therapeutic measures fall short, Pneumonectomy (PE) often emerges as the last resort for PTB patients with extensively damaged lungs [3,4].

This method, known as "physiological lung exclusion," is employed when lung resection presents notable technical hurdles or is considered unfeasible. It involves isolating either the problematic lung lobe or the entire lung from the tracheobronchial tree by dividing the bronchus and ligating the pulmonary artery, without extracting any lung tissue, while preserving the pulmonary veins. Division of the bronchus eliminates its contribution as a source of haemoptysis. Despite isolation, the lung maintains blood supply through vessels within the adhesions between its surface and the chest wall, ensuring viability of lung tissue. Additionally, the pulmonary veins remain intact, facilitating drainage of blood from the affected lung and preventing necrosis of lung parenchyma. Subsequently, the isolated lung or lobe gradually diminishes in size, leading to gradual obliteration of the pleural space as the hemithorax reduces in size. Retaining native tissue within the pleural cavity minimises the risk of pleural complications such as empyema in these high-risk patients prone to infection [1].

Before thoracotomy, OLV must be initiated. Lung-protective ventilator strategies are now standard during OLV and can be achieved using pressure or volume control. Strategies employing low-tidal-volume (<6 mL/kg) ventilation are linked to a reduced risk of postoperative respiratory failure compared to higher volumes (8 mL/kg). Low TVs should be combined with adequate Positive End-expiratory Pressure (PEEP). Low TVs without sufficient PEEP are likely to be detrimental [5].

Licker M et al., provided additional insights into the mechanisms of protective lung strategies, including the adoption of low TV with recruitment manoeuvres, a targeted fluid management approach, and prophylactic administration of inhaled β2 adrenergic agonists [6]. Schilling T et al., also highlighted another advantage of reducing TV, demonstrating reduced alveolar release of pro-inflammatory cytokines during the postoperative period of OLV [7].

In our approach, we adjusted the breathing pattern to prevent the buildup of intrinsic PEEP by prolonging expiratory times and maintaining a specific ratio of inhalation to exhalation. To address the challenge of using low TVs in order to maintain low airway pressures thereby reducing probability of ventilator-induced dependent lung injury and incidence of postoperative pulmonary complications, the authors regulated the RR to ensure sufficient ventilation.

Additionally, the authors utilised thoracic epidural anaesthesia for pain relief during and after surgery, which is known to have positive effects on cardiovascular parameters and respiratory function [8,9]. Ensuring haemodynamic stability was crucial, requiring meticulous monitoring and adjustment of intravascular volume levels.

CONCLUSION(S)

The present case report underscores the patient's extensive medical history, recurrent interventions, multifaceted approach to patient care and critical importance of thorough anaesthesia management. Through in-depth preoperative assessment and a multidisciplinary approach, the authors adeptly addressed the complexities associated with this condition. This experience highlights the value of meticulous patient evaluation, vigilant monitoring, and adaptability in anaesthesia protocols.

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