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Perioperative considerations for postpneumonectomy syndrome: A case report

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Abstract

Postpneumonectomy syndrome is a rare complication of a pneumonectomy. Patients may experience dyspnea, stridor, recurrent pulmonary infections, or dysphagia due to rotation and shift of the mediastinum. The current intervention of choice involves the placement of a tissue expander in the empty hemithorax to realign the mediastinum. Because this treatment can present with intraoperative anesthetic challenges and requires close monitoring, we present this case to highlight specific concerns that may need to be addressed including difficulties ventilating, complete airway collapse, hemodynamic instability, and pain control perioperatively.

Keywords

Pneumonectomy, postpneumonectomy syndrome, cardiothoracic anesthesia, thoracic surgery, tissue expander

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Introduction

Postpneumonectomy syndrome (PPS) is a rare condition that complicates 0.16% of pneumonectomies.[1] PPS is characterized by symptoms of progressive dyspnea, stridor, recurrent pulmonary infections, respiratory distress, and dysphagia.[1] Symptoms develop due to severe shift and rotation of the mediastinum toward the empty hemithorax. This can lead to bronchial obstruction and esophageal compression. After a right pneumonectomy, there can be counterclockwise rotation of the heart and a lateral shift toward the vacant right thorax.[2] Without treatment, respiratory failure and death can occur.[3] Prior studies have shown that placement of a tissue expander in the thorax has assisted in restoring the normal mediastinal position and allowing decompression of the airway.[4] Tissue expander placement has been shown to provide patients with lasting relief of symptoms.[5] Other treatment options include tracheobronchial stent placement or affixing the mediastinum to a pericardial patch.[6]

The perioperative management of PPS presents many challenges and concerns to surgeons and anesthesiologists. The airway compression and compromise that can accompany PPS, necessitates careful plans for ventilation and intubation pre-induction and rescue maneuvers if these fail. The potential for decreased venous return during positive pressure ventilation of a hyperinflated left lung may also need to be mitigated. We describe a case of a 55-year-old male with PPS who underwent diaphragmatic plication with the placement of a tissue expander in the right thorax. The patient provided written informed consent to publish this case report.

Case report

A 55-year-old male with a history of stage IIIA atypical carcinoid tumor who underwent a right pneumonectomy two years prior, presented with several months of extreme tachycardia and shortness of breath during intense activity which was a noted change from his baseline level of function. A computerized tomography (CT) scan of his chest revealed an elevated right hemidiaphragm and displacement of abdominal contents into the chest cavity with right atrium and ventricular compression (Figure 1). The patient was scheduled

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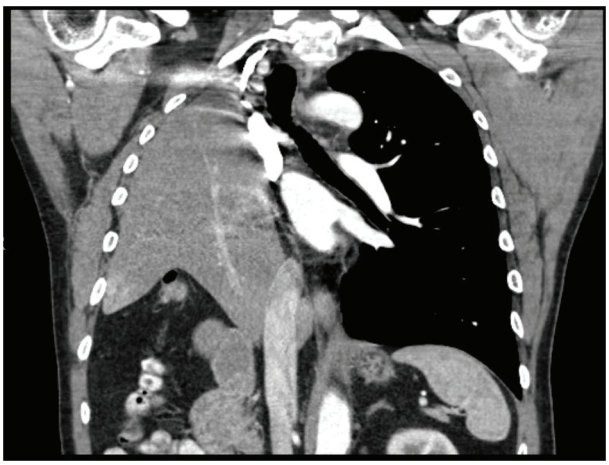

Figure 1. Preoperative CT scan noting significant compression of the right atrium and ventricle. Complete obliteration of the right intra-thoracic cavity can be noticed with the liver displaced into the apex of the thoracic cavity. The left main bronchus appears patent without signs of compression or stretching.

for a right diaphragmatic plication with placement of a tissue expander in the right chest.

Preoperative review of the CT scan was reassuring; there was no airway compression noted and ability to place a rigid bronchoscope and VV extracorporeal membrane oxygenation (ECMO) was available. After the application of standard American Society of Anesthesiologist monitors, a controlled intravenous induction was performed to maintain the preload and hemodynamic stability.[7] Manual ventilation was uncomplicated, and the trachea was intubated with a cuffed 7.5 mm single-lumen endotracheal tube (ETT) and secured at 24 cm at the lips without complications. Mechanical ventilation was accomplished using volume-controlled ventilation at a rate of 15 breaths/min and tidal volumes of 450 mL, approximately 7 mL/kg of ideal body weight. Peak airway pressures were kept below 30 cm H_2O ranging during the procedure from 20–29 cm H_2O. After being placed in left lateral decubitus position, the right chest was prepped and draped. The previous thoracotomy incision was reopened. The latissimus muscle was divided with electrocautery, serratus muscle was saved and retracted medially. The chest was entered through the fourth intercostal space and the intercostal muscle was divided. The diaphragm was identified and the small apical anterior pleural cavity space was entered without entering the abdomen. The diaphragm which was atrophic and up into the apex of the chest and adherent to the mediastinum, was freed and returned to a near normal position. The diaphragm was plicated in two layers. The chest was filled with water for volume estimation and it was approximately 850 mL, so a 750 mL Mentor© Smooth Round Moderate Plus Profile saline implant with diaphragm valve, style 2000, lot #7730370, was placed by plastic surgery after irrigation with dilute betadine (Figure 2). Hemodynamics were observed after expander placement and noted to be unchanged.

The surgery proceeded without complications. The patient received 700 mL of lactated ringers and tolerated the procedure well. Perioperative pain control was accomplished with a multimodal analgesia plan including preoperative oral medications—acetaminophen 975 mg, gabapentin 300 mg and methocarbamol 500 mg. Intraoperatively, intravenous ketorolac 15 mg and hydromorphone 0.5 mg were administered in addition to a surgeon-performed thoracic field block using a mixture of 20 mL liposomal bupivacaine, 60 mL of 0.25% bupivacaine and 220 mL of normal saline. Postoperatively, the patient was extubated in the operating room awake, following commands, hemodynamically stable and with tidal volumes at least 5 mL/kg and respiratory rate of 18/min. The patient was then transferred to the postanesthesia care unit and the postoperative chest X-ray showed a tissue expander in the right chest cavity with no other significant findings (Figure 3). The patient's postoperative pain was well controlled. The patient reported improvement in his dyspnea and was discharged on postoperative day 2. At 1 month postoperative clinic follow-up, the patient reported resolution of his tachycardia and dyspnea and one-month postoperative CT scan revealed that the expander was well positioned and the mediastinum had returned to the appropriate position with relief of the previously documented cardiac compression (Figure 4).

Overall, total surgery time was 1 h and 35 min with an estimated blood loss of 50 mL. He tolerated the procedure well and tissue expander placement successfully treated this case of postpneumonectomy syndrome.

Discussion

Postpneumonectomy syndrome is a rare complication due to shifting and rotation of the mediastinum. The mediastinum rotates counterclockwise along with herniation of the remaining lung parenchyma resulting in compression of the trachea, bronchus, esophagus, heart, and great vessels. PPS is characterized by progressive dyspnea, tachycardia, and cough from compression that eventually can result in tracheobronchomalacia.

PPS is life threatening if left untreated. Previous treatment options included suturing the pericardium to the undersurface of the sternum, abrasion of the endothoracic fascia behind the sternum to promote central fixation and intercostal myoplasty. Aortopexy and bronchial stents have also been used to alleviate compression of the aorta and main bronchus respectively. More recently, case reports have shown successful treatment with insertion of tissue expanders into the empty thoracic cavity, returning the hyperinflated lung to its correct anatomical position and alleviating the compression of mediastinal structures.[8]

The anesthetic challenges presented by a patient with PPS include potential for difficult ventilation and intubation with complete airway collapse, hemodynamic instability, and necessity for adequate pain control, maintenance of euvolemia, and early extubation.[9]

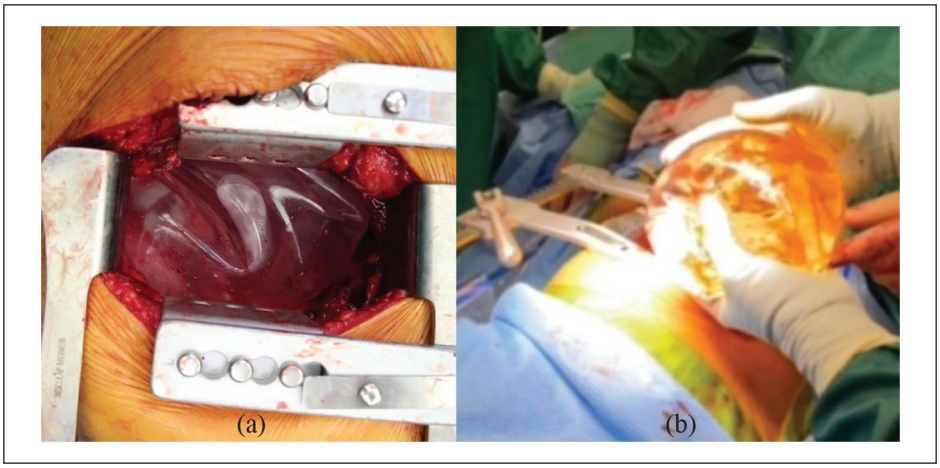

Figure 2. (a) 750 cc mentor saline implant inserted through a right sided thoracotomy. (b) Mentor smooth round moderate plus profile saline implant.

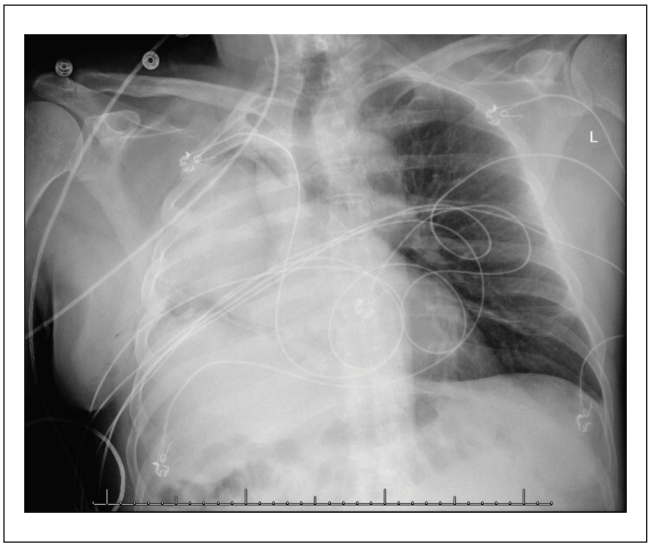

Figure 3. Post operative chest X-ray showing corrected mediastinum positioning and improvement of the herniation from the left lung on the mediastinal structures.

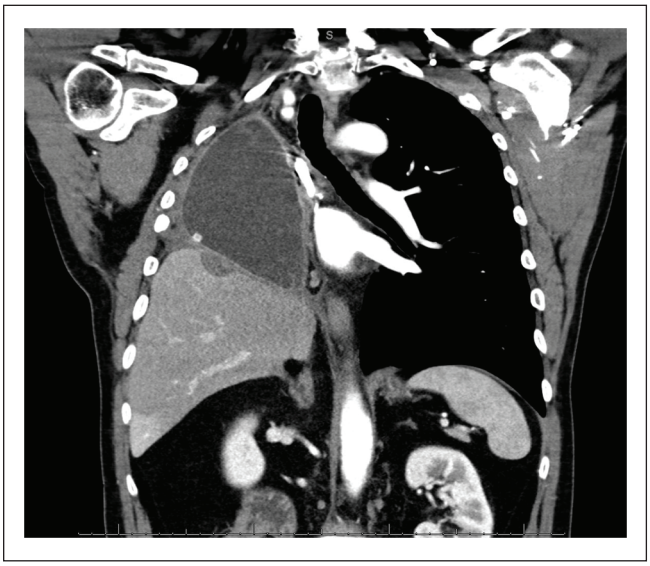

Figure 4. One month post operative CT scan showing right atrium and ventricle free of compression. Trachea, left main bronchus and esophagus in the normal anatomical position without evidence of patent without compression or malrotation.

Due to the nature of the disease process of PPS, significant care should be taken to control the airway. Endotracheal intubation presents its own challenges as the deviation and rotation of the tracheobronchial tree can significantly affect visibility with direct or indirect laryngoscopy. Additionally, an area of compression can develop malacia or stenosis that may have to be bypassed if ventilation proves to be difficult proximal to the stenosis. If there is a concern for stenosis in the bronchus, micro laryngeal ETT, airway exchange catheters, and ECMO should be considered especially if there is severe airway narrowing. Ventilation with lung-protective strategies is highly recommended as this will prevent barotrauma, decrease blood flow to the lung and allow more venous return to the right heart. If there is a concern for airway collapse on induction, preoperative considerations should include maintaining spontaneous ventilation and securing the airway before muscle relaxation or performing awake fiberoptic intubation. Venovenous ECMO can be used as a rescue in the event of tracheobronchial deviation and compression with resulting inability to ventilate. After thoroughly reviewing the CT scan of our patient, we were confidence that there was no area of stenosis in the trachea or left main bronchus and direct laryngoscopy with a standard ETT was a strategy that would likely succeed and be well tolerated by the patient.

Hemodynamic instability in the patient stems from decreasing venous return. Venous return can be significantly decreased from left lung hyperinflation, air trapping in the

ventilated lung as well as filling the tissue expander. It would be wise to consider intraoperative transesophageal echocardiography (TEE) to visualize the strain on the heart if the patient's clinical status indicates this major concern. However, the risk of esophageal compression and mediastinal deviation, along with a hyperinflated lung, could result in difficulty in placing the probe appropriately and achieving adequate views as well as increases the risk for esophageal perforation. Our patient had a CT finding of right atrial and ventricular compression from the twisting and shifting of his mediastinum causing further concerns for hemodynamic instability. However, our patient was hemodynamically stable with good biventricular function at baseline and without other significant medical history and relatively mild cardiovascular and pulmonary symptoms from his PPS, except during maximal exertion. This led to our decision to proceed without invasive monitoring including arterial line, pulmonary artery catheter and TEE as risk outweighed the benefits.

Postoperatively, pain management and early extubation are other important considerations when caring for patients with PPS. Other modalities that may be chosen include paravertebral and erector spinae plane blocks or catheters. A multimodal approach with intravenous opioids can be chosen if there are contraindications to neuraxial or peripheral nerve blocks; however, opioids must be used with caution to avoid associated respiratory depression, as these patients may be more prone due to their disease process. At our institution, we do thoracic field blocks using liposomal bupivacaine. Liposomal bupivacaine and 0.25% bupivacaine solution were infiltrated in multiple intercostal levels as well as at the incision site. Liposomal bupivacaine has been shown to provide effective pain control lasting up to 72 h while avoiding issues with anticoagulation, hypotension, epidural hematoma, and potential intrathecal injection that can be associated with thoracic epidurals.[8]

Conclusion

Postpneumonectomy syndrome is a rare complication of pneumonectomy. Anesthetic providers need to recognize and understand the pathophysiology involved in PPS. Our case report outlines that these patients can be cared for without invasive monitoring, however, providers should be cautious when treating these patients as their disease process involves airway and hemodynamic compromise. Therefore, patients should be thoroughly evaluated preoperatively with plans in place for airway and cardiovascular management. Diligence in the operating room and preparation for potential airway compression or collapse and significant hemodynamic shifts is imperative for the anesthesia providers taking care of these patients.

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Authors' contribution

SAY, AJ, VB, CB: These authors wrote the manuscript and approved the final manuscript.

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Ethics approval

Our institution does not require ethical approval for reporting individual cases or case series.

Informed consent

Written informed consent was obtained from the patient(s) for their anonymized information to be published in this article.

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