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## Case Report

# Delayed cardiac herniation after left pneumonectomy <sup>☆</sup>

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## ABSTRACT

Cardiac herniation is a rare potentially life-threatening complication that can occur after pneumonectomy, involving displacement of the heart through a pericardial defect, which can lead to hemodynamic instability, impaired cardiac function, and in severe cases, death. We describe a case of delayed cardiac herniation 1-month post left pneumonectomy for pulmonary leiomyosarcoma.

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## Introduction

Cardiac herniation following pneumonectomy was first described in 1951 by Bettman and Tannenbaum [4]. It most frequently occurs following intrapericardial pneumonectomy, with an incidence rate between 0.2% and 0.5% [1]. Most cases occur within 24 hours of surgery, with rarity of cases beyond 24 hours attributed to rapid formation of adhesions between the heart and pericardium within the first 72 hours following surgery [1–3]. Timely diagnosis is critical as mortality is 100% in unrecognized cases and 50% in cases in which the diagnosis is made [6,7].

## Case report

A 78-year-old woman underwent left pneumonectomy, with intrapericardial control of the pulmonary vessels, for treatment of a 70 mm leiomyosarcoma of the left lung, following failed response to preoperative chemotherapy. Initial clinical postoperative course was unremarkable. Serial postoperative chest radiographs demonstrated mediastinal shift to the left, within expected postsurgical limits. Histopathology confirmed leiomyosarcoma, with clear resection margins.

At 1-month postoperative review, the patient complained of shortness of breath and was found to have significant

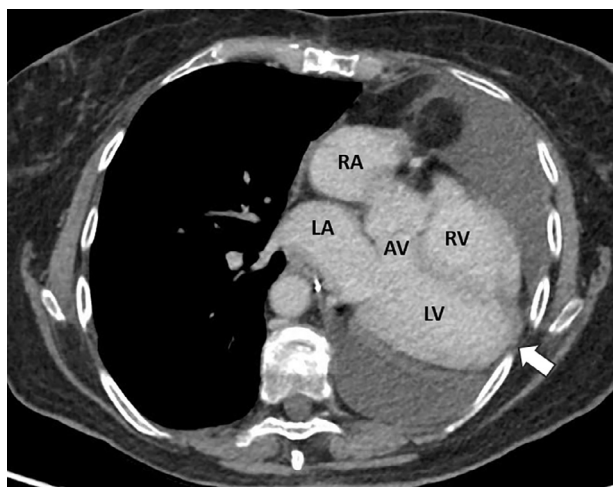
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**Fig. 1** – Axial CT demonstrating complete left-sided cardiac herniation with cardiac apex pointing posterolaterally and abutting the chest wall (arrow). LV, left ventricle; RV, right ventricle; LA, left atrium; RA, right atrium; AV, aortic valve.

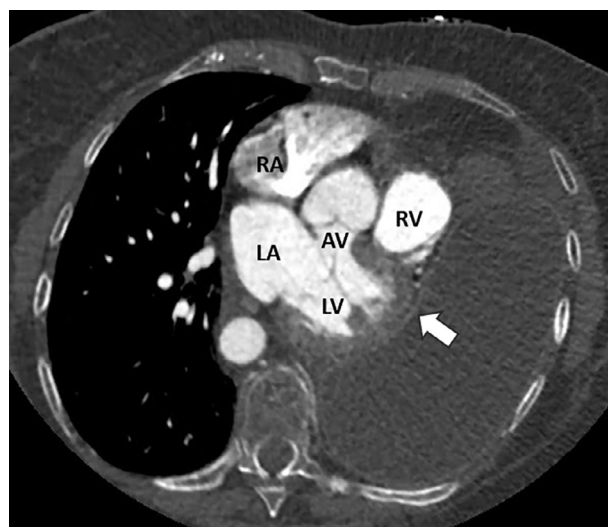
postural hypotension. A chest radiograph demonstrated increased mediastinal displacement into the left pneumonectomy space. Chest computed tomography (CT) confirmed significant cardiac displacement and levorotation, with the cardiac apex abutting the posterolateral chest wall. A pericardial defect was not visualized (Fig. 1).

Subsequent rethoracotomy revealed cardiac herniation into the left hemithorax through a small pericardial defect over the lateral aspect of the left ventricle, which had not been completely closed during the initial surgery. There was no evidence of myocardial strangulation. There was additional displacement of the mediastinum into the postpneumonectomy space. The heart was repositioned and the pericardial defect was repaired with bovine pericardium. Two saline filled tissue expanders were placed in the postpneumonectomy space to prevent displacement of the mediastinum (Fig. 2).

Postoperatively, the patient's postural hypotension resolved, suggesting this had been a consequence of impaired ventricular function secondary to cardiac herniation. The patient was discharged on postoperative day 6.

## Discussion

Cardiac herniation through a pericardial defect is a rare condition which may be iatrogenic, traumatic, or congenital in origin [5]. Iatrogenic herniation is most common in the immediate postoperative period, though delayed presentation may occur due to gradual enlargement of the pericardial defect, or intentional incomplete closure of the pericardial defect during surgery [5]. Radiologists need to be aware of this possibility, which is associated with substantial mortality, especially when not recognized [6,7].

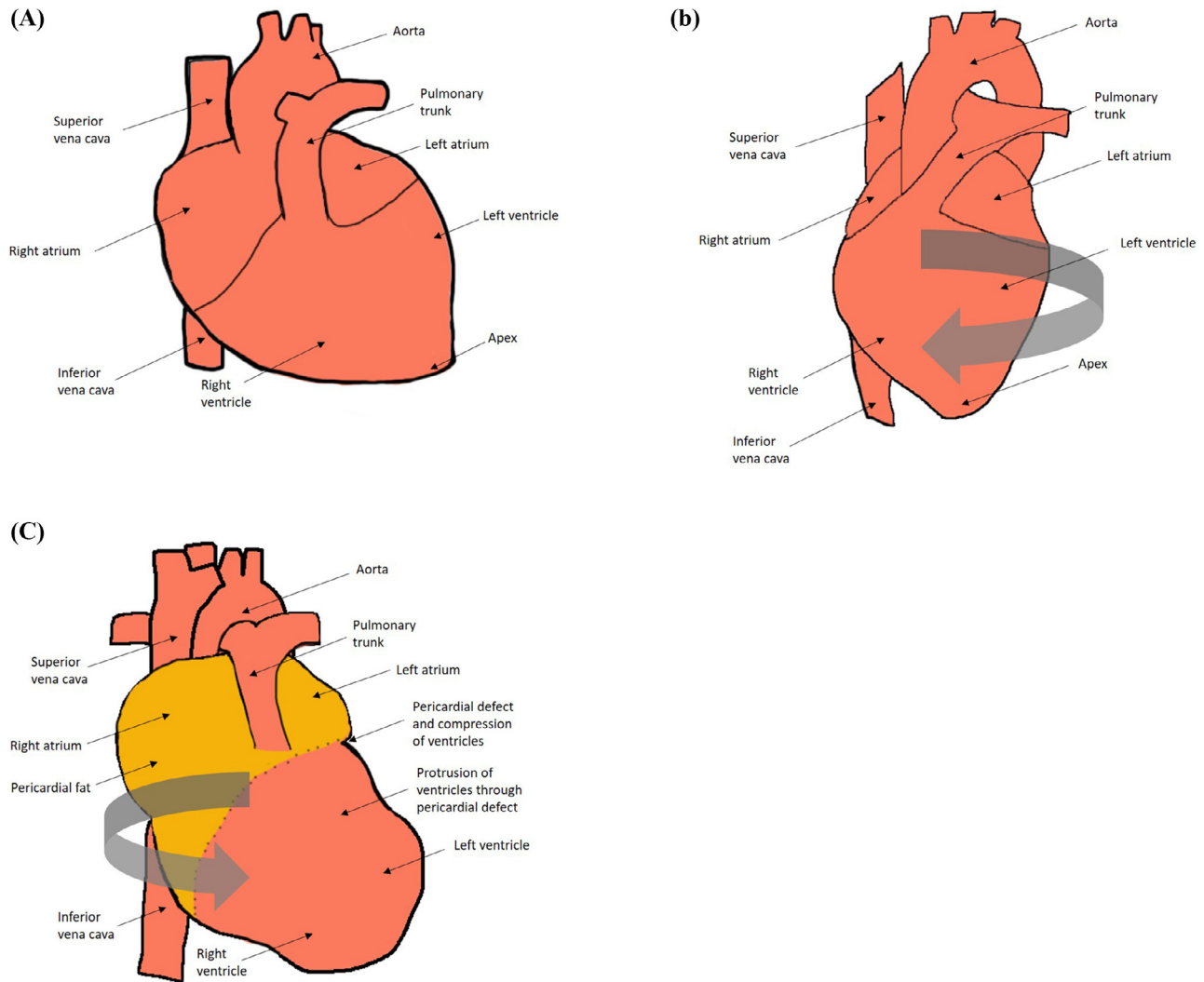


**Fig. 2** – Axial CT 4 months post rethoracotomy with two tissue expanders within the left pneumonectomy space facilitating midline position of heart and mediastinum. There has been a reduction in degree of posterior rotation of cardiac apex (arrow). LV, left ventricle; RV, right ventricle; LA, left atrium; RA, right atrium; AV, aortic valve.

Pathophysiological consequences and associated clinical signs of cardiac herniation vary depending on the side of herniation and the degree of cardiac displacement and rotation (Fig. 3). Right sided herniation tends to be complete, with counterclockwise rotation of the heart leading to torsion of the great vessels and potential obstruction of the superior and inferior vena cava [1,5]. Resulting decreased venous return can dramatically reduce cardiac output and blood pressure. Left sided herniation is more often partial, and may lead to strangulation of the ventricles as they pass through the pericardial defect with resulting outflow obstruction and diminished cardiac output [8]. Subsequent cardiac edema and congestion, as well as reduced coronary artery flow can lead to myocardial ischemia [5]. Complete left sided cardiac herniation is less common and can lead to rotation and obstruction of the great vessels with arterial outflow obstruction or decreased venous return [9]. Prognosis is thought to be better in complete cardiac herniation rather than partial herniation, as partial herniation harbors the risk of cardiac incarceration and myocardial ischemia [9].

Radiological findings play a crucial role in the diagnosis of cardiac herniation. A postoperative chest radiograph demonstrating significant cardiac displacement, not secondary to a large pleural effusion, atelectasis, or tension pneumothorax, should raise suspicion for cardiac herniation as a diagnostic possibility [10].

CT more accurately demonstrates the presence of cardiac axis rotation, or focal pericardial discontinuity, as well as stretching or rotation of the great vessels [11]. A tear in the pericardium may be visible before the onset of herniation [12]. A collar or waist may be visible where the heart is constricted by the pericardial defect at the site of herniation, or an empty pericardial sac may be seen after herniation of the heart into



**Fig. 3 – (A) Schematic of heart in anatomical position as viewed in the coronal plane. (B) Rotation of the heart around its axis and torsion of the great vessels/chambers as would be seen in right-sided complete cardiac herniation. Both left-sided and right-sided complete cardiac herniation may lead to torsion of the great vessels and chambers of the heart. (C) Partial cardiac herniation with leftwards rotation/shift of the heart. Partial herniation of the heart is more typical in left-sided cardiac herniation and may involve strangulation of the ventricles and subsequent myocardial ischemia.**

the thoracic cavity [13]. CT may also depict findings associated with impaired right ventricular filling, such as a dilated inferior vena cava, reflux of contrast into the inferior vena cava, or a deformed ventricular contour [13]. CT is an especially valuable tool when findings on plain radiograph are subtle or non-specific, such as in our case.

## Conclusion

Delayed cardiac herniation is a rare complication of intrapericardial pneumonectomy, and is associated with high mortality, even when successfully diagnosed. Prompt diagnosis of the condition relies on a high index of clinical suspicion and radiological awareness of associated imaging features which facilitates diagnosis and timely intervention.

## Patient consent

Written informed consent was obtained from the patient for publication of this case report and any accompanying images.

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