

A case of cardiac herniation after extrapleural pneumonectomy for malignant thymoma

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Abstract A 44-year-old man underwent radical thymectomy for malignant thymoma 5 years ago. He subsequently underwent right extrapleural pneumonectomy because a right pleural metastatic lesion had developed. The operation was completed uneventfully. Immediately after arrival at the intensive care unit, the patient appeared restless and in pain. His heart rate increased to 140 bpm and then abruptly decreased to 20–30 bpm concomitant with profound systolic hypotension of 30–40 mmHg. Chest X-ray showed that the heart was shifted into the right thorax. Emergent re-thoracotomy was performed and the heart was found to be malrotated and herniated from an upper defect of the pericardial patch in the right thoracic cavity. The heart was returned to the pericardium and the defect was covered with a pericardial patch. The blood pressure and heart rate became stable. He was transferred to the surgical ward from the intensive care unit on the first postoperative day. The rest of the course was uneventful and the patient was discharged on the seventh postoperative day. The incidence of cardiac herniation after extrapleural pneumonectomy following chemotherapy for malignant pleural mesothelioma has been reported to be around 3%. The risk of cardiac herniation should always be considered, especially after extrapleural pneumonectomy.

Keywords Cardiac herniation · Extrapleural pneumonectomy

Introduction

Extrapleural pneumonectomy is known as a radical surgical procedure for advanced-stage malignant pleural mesothelioma, lung cancer, and thymoma. Recent studies have reported that the postoperative complication rates were around 60%, with a perioperative mortality of 3% [1, 2]. Although cardiac herniation is a life-threatening complication, with a mortality rate of 50–100% following intrapericardial pneumonectomy [3–6], early diagnosis and immediate surgical treatment may decrease the mortality rate. Cardiac herniation after extrapleural pneumonectomy occurs most commonly within the first 24 h of the postoperative period. We present a case of cardiac herniation complicated by cardiovascular collapse immediately following extrapleural pneumonectomy.

Case history

A 44-year-old man underwent radical thymectomy for malignant thymoma and received chemotherapy for right pleural dissemination concurrently, 5 years ago. He was subsequently scheduled for right extrapleural pneumonectomy because a right pleural lesion had developed. He had no clinical history of cardiovascular disease or problems in the cardiovascular system. The preoperative ECG was within normal limits, and echocardiography demonstrated normal wall motion with a left ventricular ejection fraction of 70%.

Before inducing general anesthesia, an epidural catheter was inserted in the T5–T6 intervertebral space for

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postoperative analgesia. Anesthesia was induced and maintained with intravenous infusion of propofol and remifentanyl. The trachea was intubated with a 35 French left-sided double-lumen endobronchial tube. After intubation, the left radial artery catheter was inserted. Neuromuscular blockade was maintained with intermittent bolus injections of rocuronium.

Pressure-controlled ventilation was used during left-sided one lung ventilation with a maximum airway pressure up to 20 cmH₂O and 100% oxygen. Pulse oximetry showed an SpO₂ of 98–100%. The systolic blood pressure and heart rate ranged from 100 to 130 mmHg and 70 to 90 bpm, respectively. The operation was completed uneventfully. The total estimated blood loss was 2,320, and 1,120 g of red cell concentrates (RCC) and 450 g of fresh frozen plasma (FFP) were transfused. At the end of one-lung ventilation, 0.375% ropivacaine 6 ml and fentanyl 0.1 mg were injected and continuous infusion of 0.2% ropivacaine (5 ml/h) and fentanyl (20 µg/h) was started through the epidural catheter for postoperative analgesia.

The patient was turned to the supine position from the left lateral decubitus position and extubated sequentially after the operation was completed. Several minutes after extubation, the systolic blood pressure declined from 110 to 70 mmHg, although the heart rate remained at 90 bpm. Because intravascular volume replacement and administration of dopamine infusion at 5 µg/kg/min reversed this hypotensive episode, it was considered that the episode was caused by vasodilatation and relative hypovolemia due to the epidural analgesia. The patient was transferred to the intensive care unit (ICU). Immediately after arrival at the ICU, the patient appeared restless and in pain. The ECG showed low voltage in the QRS waves (Fig. 1). The heart rate increased up to 140 bpm and then abruptly declined to 20–30 bpm concomitant with profound systolic hypotension of 30–40 mmHg. The state of shock was reversed by rapid intravascular volume replacement and administration of atropine 0.5 mg, phenylephrine 0.3 mg, and dopamine infusion at 5 µg/kg/min. We considered cardiac herniation or pericardial tamponade as the differential diagnosis of this state. Chest X-ray showed that the heart was shifted

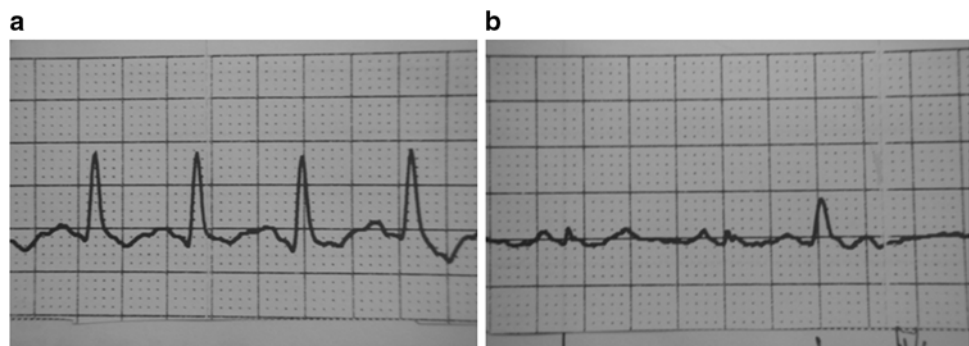
into the right thorax (Fig. 2). The patient was returned to the left lateral decubitus position and was immediately transferred back to the operating room. Although heart rate and systolic blood pressure recovered to 91 bpm and 114 mmHg after the position change, dopamine infusion was continued. The voltage of the QRS waves returned to baseline.

Anesthesia was induced with thiopental, and a single endotracheal tube was inserted with vecuronium after turning the patient to the supine position. The position was changed to the left decubitus after intubation. Emergent re-thoracotomy was performed, and the heart was found to be malrotated and herniated from an upper defect of the pericardial patch in the right thoracic cavity. The defect, which was about 5 cm² in size, was caused by a shift of the pericardial patch to the lower side. The heart was returned to the pericardium and the defect was covered with a pericardial patch. The blood pressure and heart rate remained stable with dopamine infusion at 5 µg/kg/min throughout the operation. Although the total estimated blood loss was 100 g, RCC 560 g and FFP 450 g were



Fig. 2 Postoperative anteroposterior chest radiograph showing a mediastinal shift toward the pneumonectomy side

Fig. 1 ECG waves on the heart monitor upon arrival at the intensive care unit (**a**) and several seconds after that (**b**)



transfused. The patient was not extubated so as to prevent hypoxia due to lung edema as a consequence of the excess volume infusion during volume resuscitation, and he was returned to the ICU.

The patient was extubated and dopamine infusion was tapered off about 9 h after the emergent operation. He was transferred to the surgical ward on the first postoperative day. The rest of the course was uneventful and the patient was discharged on the seventh postoperative day.

Discussion

More than 50 cases of cardiac herniation after intrapericardial pneumonectomy have been reported since 1948 [7, 8]. Although it can occur as a result of any size of pericardial defect, as reported previously, a larger defect may cause this complication more frequently. Opiz et al. [2] suggested that the incidence of cardiac herniation after extrapleural pneumonectomy following chemotherapy for malignant pleural mesothelioma was around 3%. This rate would be higher than the incidence of cardiac herniation after intrapericardial pneumonectomy with pericardium defect. The risk of cardiac herniation should always be considered, especially after extrapleural pneumonectomy.

The clinical characteristics and findings for the diagnosis of cardiac herniation are as follows. In right-sided cardiac herniation, hypotension and reflex tachycardia are caused by obstruction of the superior and inferior vena cavae. The radiologic findings include displacement of the heart with the cardiac apex located on the right, a globular right cardiac border protruding into the right chest (snow cone sign), and a notch on the side of the cardiac vascular pedicle. With left cardiac herniation, compression and compromise of the left ventricular wall by the pericardial edges result in arrhythmia and myocardial ischemia. The radiological findings include a hemispherical shape of the left heart border and an incisura between the great vessels and the herniated left cardiac chambers [9]. Although the ECG may change due to dislocation and torsion of the heart, the pattern is not specific [10]. Thoracoscopy was used to find the herniated heart under local anesthesia [11]. Echocardiography is noninvasive and is available at the bedside to confirm or support the diagnosis. Echocardiographic findings include a mass effect of the pericardium in elongation and compression of the atrium, and the ventricle can appear bulbous and distorted [8]. In this patient, cardiac herniation possibly occurred when the patient was turned to the supine from the lateral decubitus position. Chest X-ray or echocardiography could have been used to make this diagnosis in the operating theater.

Emergent re-thoracotomy is the only resuscitative treatment for cardiac herniation. Temporarily returning to the lateral decubitus position and inflating the thoracic cavity with air, which reposition the heart postpneumonectomy, are effective ways to facilitate recovery from the state of shock [12, 13]. In addition, it is important to utilize several approaches to prevent cardiac herniation: mechanical ventilation, hyperinflation of the remaining lung, the application of suction to the chest drainage tubes, and coughing on extubation may facilitate dislocation of the heart [5, 14].

In summary, we present a case of cardiac herniation complicated by cardiovascular collapse immediately following right extrapleural pneumonectomy. He presented with profound hypotension after the operation in the supine position and was diagnosed with cardiac herniation by chest X-ray. Emergent re-thoracotomy showed that the heart was malrotated and herniated from an upper defect of the pericardial patch in the right thoracic cavity. We should consider cardiac herniation in the differential diagnosis of hypotension that occurs immediately after extrapleural pneumonectomy.

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