

## **Acute Cardiac Herniation after Right Pleuropneumonectomy (Case Report and Review of Literature)**

Nora Ismail Abbas

1-MD Critical Care medicine, Ass. Professor in Critical Care department, Faculty of medicine, Cairo University, Cairo, Egypt

**Mailing Address:** Critical Care department, Kasr el Ainy hospital Al-Saray Street, El Manial Cairo, Egypt.

E-mail: [Narnar\\_77@yahoo.com](mailto:Narnar_77@yahoo.com)

*Key words* Cardiac herniation, Pleuropneumonectomy surgery, pleuropneumonectomy complications, Pleural Mesothelioma, chest X-ray

### **ABSTRACT**

Extra-pleural pneumonectomy (EPP) is an extensive surgery for management of pleural mesothelioma that is associated with perioperative morbidity of 60-63%. Extrapleural pneumonectomy (EPP) or pleuropneumonectomy for diffuse malignant pleural mesothelioma is a radical surgery which includes en bloc resection of the pleura, lung, ipsilateral hemidiaphragm and anterior pericardium. Acute cardiac herniation an extremely rare post-operative complication can cause immediate mortality in more than 50% of cases. **Prevention and early recognition and management are necessary for favorable outcome. We report here the case of fatal acute cardiac herniation following right pleuropneumonectomy that caused sudden**

circulatory collapse upon patient manipulation shortly after admission. The patient died after futile cardiopulmonary resuscitation while preparing for emergency cardiothoracic surgery. Prevention of acute cardiac herniation by adequate closure of the pericardial defect, avoiding excessive manipulation of the patient and early recognition and management by emergency cardiothoracic surgery can lead to better outcome.

## INTRODUCTION

Extra-pleural pneumonectomy (EPP) is an extensive surgery associated with perioperative morbidity of 60-63% [1-2]. Extrapleural pneumonectomy (EPP) or pleuropneumonectomy for diffuse malignant pleural mesothelioma is a radical surgery which includes en bloc resection of the pleura, lung, ipsilateral hemidiaphragm and anterior pericardium [3]. Cardiac herniation is an extremely rare post-operative life-threatening condition associated with a mortality rate (50–100%) [4-5].

We hereby report here the case of fatal acute cardiac herniation following right pleuropneumonectomy that caused sudden circulatory collapse upon patient manipulation shortly after admission. The patient died after futile cardiopulmonary resuscitation while preparing for emergency cardiothoracic surgery.

## Presentation of Case

We report here the case of acute cardiac herniation in a young male patient 40 years old who worked as a clerk in a cement factory, diagnosed with mesothelioma (by a frozen biopsy) 2 years ago who received chemotherapy (Gemzar) that caused bone marrow depression. The patient suffered progressive dyspnea increasing in severity (two months ago) then an operative decision was taken. He underwent right pleuropneumonectomy and excision of the 6<sup>th</sup> rib, right cupula of the diaphragm and part of the pericardium with the pericardial defect left open. Acute cardiac herniation occurred one hour post-intensive care unit (ICU) admission with patient manipulation. The patient suddenly collapsed with acute deterioration in hemodynamics. Chest x-ray showed acute cardiac herniation. Unfortunately, the patient died after a futile CPR while preparing for urgent thoracotomy.

## **DISCUSSION**

Malignant mesothelioma is a rare neoplasm with higher incidence in hereditary collagen diseases such as Ehlers-Danlos syndrome and Marfan's syndrome [6].

### **Etiology & Pathophysiology**

Asbestos exposure is the leading cause of mesothelioma.

Asbestos causes mesothelial cells inflammation, permanent scarring, cellular damage and cancer.

Asbestos stimulates free radicals production and can trigger cellular onco-proteins production. [7]

### **Other Potential Risk Factors**

Non-asbestos mineral fibers such as erionite and taconite, radiation exposure, Simian virus 40, a contaminant of polio vaccine [8], Chest injuries, chronic inflammation, genetics and organic chemicals. [9]

### **Diagnosis**

Mesothelioma diagnosis is usually formulated within three to six months of a patient's first consultation. [10]

Medical history of prior asbestos exposure, past and present health problems (especially respiratory diseases), a family history of mesothelioma and smoking status.

Mesothelioma symptoms usually start 15 to 50 years after asbestos exposure.[9]

The most common pleural mesothelioma presentations include:

Chest Pain (64% of patients). Shortness of breath (dyspnea) (79%). Dry cough or wheezing (36%), pleural effusions (90%), weight loss (30%), fatigue, reduced chest expansion, barely audible or harsh breathing sounds, signs of pleural mass and/or localized tenderness.

Dyspnea is the first symptom of pleural mesothelioma in 90% of cases [9]. The diagnosis of mesothelioma should be considered in any patients with unilateral pleural effusion or thickening, especially if chest pain is present [11].

Pleural mesothelioma can cause pain by irritating intercostal nerves by infiltrating into the chest wall. Rarer manifestations include phrenic nerve palsy, irritative cough, paraneoplastic phenomena, and spontaneous pneumothorax [12].

Imaging tests chest X-ray, computed tomography (CT), magnetic resonance imaging (MRI) or positron emission tomography (PET) scan. [13].

### **Biopsies**

Thoracoscopy, Bronchoscopy. Laparoscopy for peritoneal mesothelioma.

Mediastinoscopy is performed to detect neck and chest lymph nodes metastases.

In the guidelines, video-assisted thoracoscopic surgery (VATS) is recommended for the diagnostic assessment of pleural effusions of unclear origin . [9]

### **Mesothelioma Staging**

Butchart Staging System It was the first staging system developed for mesothelioma and can determine the case severity regardless of its histology. [14]

The European Pneumological Society [9] recommends using the tumor-nodes-metastases (TNM) classification of the Union for International Cancer Control (UICC) [15].

### **Mesothelioma Treatment Options**

#### **Surgery**

Being nearly always diagnosed in its later stages, curative surgery is typically not an option for mesothelioma. Once extra-pleural metastases occur, surgery is only palliative. Pleurodesis involves

injecting talc into the lungs to prevent pleural fluid re-accumulation. Palliative pleurectomy for severe cases involves removing the pleura and can control fluid re-accumulation, decreases pain and dyspnea.[16]

### **Advancements in Mesothelioma Surgery**

Extrapleural pneumonectomy is a recent extensive surgery that has prolonged survival rate in those diagnosed with early stage disease. This procedure, involves the surgical resection of the entire affected lung, pleurectomy, removal of the pericardium and the diaphragm.

Contraindications to surgery are: nodal metastases, non-localized disease on Computed Tomography scan including extensive or multiple chest wall invasion, ejection fraction <45%, and predicted post-operative forced expiratory volume in the first second (FEV1) FFEV1 <1 litter, room air arterial PaCO<sub>2</sub> >45mmHg and PO<sub>2</sub> <65mmHg.[3]

Intra-operative chemotherapeutic agent (Cisplatin) will be applied directly to the affected area to eliminate any remaining malignant cells. [17]

Following the application of chemotherapy, the diaphragm and pericardium are reconstructed with prosthetic material.

### **Radiation Therapy**

It is recommended if a patient is unfit for surgery or chemotherapy as palliative therapy. [9]

Radiation is associated with the fewest side effects and is typically more tolerable than chemotherapy.

### **Chemotherapy**

Like radiation, chemotherapy provides no cure but can be extremely effective palliative treatment.

### **Acute Cardiac herniation**

Cardiac herniation occurring post-lung cancer surgery involving pericardiotomy or pericardiectomy was first reported in 1948 by Bettman et al. [18]. In 1999, Kimura et al [19] reported that cardiac herniation post lung surgery was more frequent on the right side than on the left side.

### **CLINICAL FINDINGS**

The symptoms of cardiac herniation are related to the pericardial defect location. On the right side, induces obstructive shock, torsion of both superior vena cava SVC and the inferior vena cava (IVC), with subsequent reduction of cardiac filling, hypotension, and sharp rise of central venous pressure. [20] On the left side, cardiac herniation may cause ventricular fibrillation and myocardial infarction due to strangulation of the ventricular wall by the pericardial edges. [21]. Asymptomatic cardiac herniation discovered accidentally by X-ray immediately post-operative has been reported. [22]

### **CAUSES AND PRECIPITATING FACTORS**

Most cases of cardiac herniation occurred after pneumonectomy.

In some cases, however, it occurred after lobectomy [23]. 75% of the reported cases, developed before the end of the surgery, i.e., during repositioning of the patient [24]. The deficiency of reported cases of late herniation (more than 24 hours postoperatively) is probably the result of rapid development of adhesions between the heart and the pericardium [25]. Factors which can trigger cardiac herniation include coughing, positive pressure mechanical ventilation, suction on the chest drains, re-positioning of the patient with the operated side downwards [4], aspiration of pneumonectomy space and inflation of left lung [26], phrenic nerve paralysis and large defect(5 x5cm) [25].

### **Differential Diagnosis**

It is likely to be misdiagnosed by more common causes of progressive shock, such as airway obstruction, cardiac arrest, or intrathoracic and mediastinal bleeding. The latter is particularly difficult to differentiate since heart sounds may be distant in cardiac prolapse, suggesting tamponade. Electrocardiographic changes are frequently nonspecific.

The chest film is amongst the most important diagnostic examination and must be performed as soon as possible. [27]

### **Radiographic X-RAY findings**

Radiographic signs of cardio-pericardial prolapse are:

1. A clearly abnormal cardiac contour. Examples include a spherical heart with an incisura between the cardiac mass and the great vessels (cardiac incarceration in a small pericardial rent) [28-25-29] and fan lateral and posterior displacement of the cardiac apex which may come to nest in the posterior costo-phrenic angle (ipsilateral complete herniation through a large defect including an organo-axial volvulus of the heart). [28]
2. The cardiac apex on the wrong side of the chest, usually in the hemithorax where surgery occurred.
3. An empty pericardial sac containing air from an associated pneumothorax or the pneumonectomy space.

### **Side and Extent of cardiac prolapse**

Partial is more fatal than complete cardiac prolapse, because the former results in cardiac incarceration and myocardial ischemia [30]. Right-sided cardiac herniation which tends to be complete is accompanied by volvulus of the heart, torsion of the atriocaval junctions, and right ventricular outflow tract obstruction.

### **Treatment & Prophylaxis measures**

Treatment aimed at immediate replacement of the heart to its normal position and closure of the defect. Patch closure has often been used since the 1970s. Materials used to fill the pericardial defect include the patient's (fascia lata, pleural flaps) and artificial materials such as Teflon grafts or expanded-polytetrafluoroethylene (EPTFE) patches. Fascia lata is widely used in plastic surgery [31]. Pleural flaps can be obtained easily in only a few minutes, but their strength is insufficient. Teflon grafts are strong enough. However, since Teflon is polyporous, fibrous tissue hyperplasia can cause constrictive pericarditis or infection. On the other hand, being strong enough, simple, with low risk of infection, EPTFE patches are often used [32]. Junzo shimuso [32] recommended that when pneumonectomy is performed pericardial defects should be closed with a prosthetic patch, regardless of the defect's size particularly when rib resection is performed.

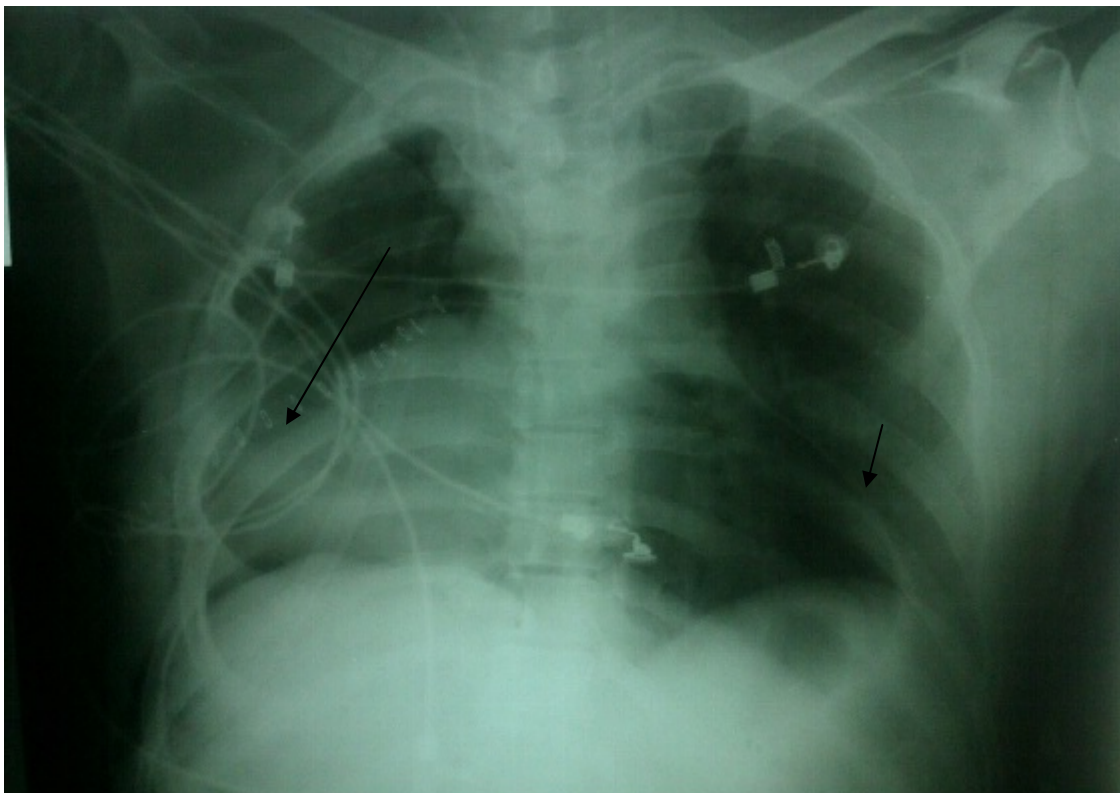
### **Chest X ray**

1-A clearly abnormal cardiac contour.

2-The cardiac apex on the wrong side of the chest, usually in the hemithorax where surgery occurred.

3- An empty pericardial sac containing air from an associated pneumothorax or the pneumonectomy space

### **Figure Legend**



Male patient 45 years old. Chest X-ray showing acute cardiac herniation post pleuro-pneumectomy.

### **CONCLUSION**

Acute cardiac herniation although rare yet is an important post pleuropneumectomy highly fatal complication that needs to be in mind to fill in the Differential diagnosis of post-pleuroneumectomy shock and cardiac arrest.



Prophylaxis avoid repositioning the patient with the operated side downwards, avoid unnecessary manipulation of the patients, follow-up serial chest X-rays.

The diagnosis needs to be always kept in mind and is readily obtained by chest X-ray.

Treatment should be an emergency cardiac surgery for closure of the defect.

## **FUNDING N/A.**

## **COMPETING INTERESTS**

The authors declared that no competing interests exist.

## **CONSENT & ETHICAL STANDARDS (WHERE EVER APPLICABLE)**

Consent: An informed consent was obtained from the patient first degree relative. The patient personal data are hidden as much as possible.

## **REFERENCES**

1. Stewart DJ, Martin-Ucar AE, Edwards JG, West K, Waller DA.. Extrapleural pneumonectomy for malignant pleural mesothelioma: the risks of induction therapy, right sided procedures and prolonged operations. Eur J Cardiothorac Surg 2005; 27:373-8. PMID:15759050.  
<https://doi.org/10.1016/j.ejcts.2004.12.028>
2. Sugarbaker DJ, Jaklitsch MT, Bueno R et al. Prevention, early detection, and management of complications after 328 consecutive extrapleural pneumonectomies. J Thorac Cardiovasc Surg 2004; 128:138-46. PMID: 15224033 DOI: 10.1016/j.jtcvs.2004.02.021
- 3- Grondin SC, Sugarbaker DJ. Pleuropneumonectomy in the treatment of malignant pleural mesothelioma. Chest. 1999 Dec;116(6 Suppl):450S-454S  
PMID: 10619506
- 4- Self RJ, Vaughan RS. Acute cardiac herniation after radical pleuropneumonectomy. Anaesthesia 1999; 54:564–6. PMID:10619506

- 5- Veronesi G, Spaggiari L, Solli PG, Pastorino U. Cardiac dislocation after extended pneumonectomy with pericardioplasty. *Eur J Cardiothorac Surg* 2001;19:89–91. PMID: 11163569
- 6- Mario Bisconti, Alberto Bisetti, Paolo Bidoli. Case Report Malignant Mesothelioma in Subjects with Marfan's Syndrome and Ehlers-Danlos Syndrome: Only an Apparent Association? *Respiration* 2000;67:223-228 Vol. 67, No. 2, 2000 PMID: 10773800 (DOI: 10.1159/000029493)
- 7- Rahman, Mohamed Abdel; Gaafar, Rabab M.; Baki, Hoda A.; Elhosini, Hesham M.; Kasem, Fatma A. Prevalence and pattern of lymph node metastasis in malignant pleural mesothelioma: P1-105 *Journal of Thoracic Oncology*. August 2007 - Volume 2 - Issue 8 - pp S591-S592. PMID:18640302
- 8- Zekri AR, Bahnassy AA, Mohamed WS et al. Evaluation of simian virus-40 as a biological prognostic factor in Egyptian patients with malignant pleural mesothelioma. *Pathol Int.* 2007 Aug;57(8):493-501. PMID:17610473
- 9--Scherpereel A, Astoul P, Baas P, Berghmans T et al. European Respiratory Society/European Society of Thoracic Surgeons Task Force. Guidelines of the European Respiratory Society and the European Society of Thoracic Surgeons for the management of malignant pleura mesothelioma. *Eur Respir J.* 2010;35:479–495. PMID: 19717482 [[PubMed](#)]
- 10- Champbell N, Kindler H. Update on malignant pleural mesothelioma. *Semin Respir Crit Care Med.* 2011;32:102–110. PMID: 21500129 [[PubMed](#)]
- 11- Gill R. Imaging of mesothelioma. *Recent Res Cancer Res.*2011;189:27-55.
- 12-Neumann V, Günther S, Müller K, Fischer M. Malignant mesothelioma - German mesotheliom register 1987 - 1999. *Int Arch Occup Health.* 2001;74:383–395. PMID: 21479894 [[PubMed](#)]
- 13-Kondola, S; Manners, D; Nowak, AK (12 February 2016). "Malignant pleural mesothelioma: an update on diagnosis and treatment options.". *Therapeutic advances in respiratory disease.* **10**: 275–88. [doi:10.1177/1753465816628800](https://doi.org/10.1177/1753465816628800). PMID 26873306.

- 14- Butchart E, Ashcroft T, Barnsley W, Holden MP.: Pleuropneumectomy in the management of diffuse malignant mesothelioma of the pleura: experience with 29 patients. *Thorax* 1976, 31:15–24. PMID:1257933
- 15- Wittekind C, Meyer H. 7. Auflage. Weinheim: Wiley-VCH; 2010. TNM Klassifikation maligner Tumoren.
- 16- Held-Warmkessel J, Schiech L. **Caring** for a **patient** with **malignant pleural effusion**. *Nursing*. 2008 Nov;38(11):43-7; quiz 48. PMID: 18989205 doi: 10.1097/01.NURSE.0000341079.53082.b1.
- 17-Chang MY, Sugarbaker DJ. Innovative therapies: intraoperative intracavitary chemotherapy. *Thorac Surg Clin*. 2004 Nov;14(4):549-56. PMID: 15559062 DOI: 10.1016/S1547-4127(04)00109-4
- 18- Bettman RB, Tannenbaum WJ. Herniation of the heart through a pericardial incision. *Ann Surg* 1948; 128:1012–4. PMID:17859240
- 19-Kimura T, Chiba Y, Ihaya A, Sasaki M, Taniguchi T, Hiramatsu Y. A case of acute right coronary artery occlusion with cardiac herniation following right pneumonectomy. *J Jpn Assoc Chest Surg* 1999; 13: 660–4
- 20-Vanoverbeke HM, Schepens MAAM, Knaepen PJ. Acute cardiac herniation following intrapericardial pneumonectomy. *Acta Chir Belg* 1998; 98: 98–100. PMID: 9615167
- 21-Cassorla L, Katz JA. Management of cardiac herniation after intrapericardial pneumonectomy. *Anesthesiology* 1984; 60: 362–4. PMID: 6703392
- 22-Kawamukai K, Antonacci F, Di Saverio S, Boaron M. Acute postoperative cardiac herniation. *Interact Cardiovasc Thorac Surg*. 2011 Jan;12(1):73-4. Epub 2010 Oct 12. PMID:20940166.
- 23-Ohri SK, Siddiqui AA, Townsend ER. Cardiac torsion after lobectomy with partial pericardectomy. *Ann Thorac Surg* 1992; 53: 703–5. PMID: 1554288
- 24-Baaijens PFJ, Hasenbos MAWM, Lacquet LK, Dekhuijzen PNR. Cardiac herniation after pneumonectomy. *Acta Anaesthesiol Scand* 1992; 36: 842–5.

25-Deiraniya AK. Cardiac herniation following intrapericardial pneumonectomy. *Thorax* 1974; 29:545–52. PMID:4428454

26-Higginson, J. F. Block dissection in pneumonectomy for carcinoma. *Journal of Thoracic Surgery*, 1953 Jun;25(6):582-99. PMID:13062344

27- Arndt RD, Frank CG, Schmitz AL, Haveson SB. Cardiac herniation with volvulus after pneumonectomy. *Am J Roentgenol* 130:155-156, January 1978. PMID:413402

28- Gates GF, Sette AS, Cope JA: Acute cardiac herniation with incarceration following pneumonectomy. *Radiology* 94:561-562, 1970. PMID: 5413895 DOI: 10.1148/94.3.561

29-Tschersich HU, Skonapa V Jr, Fleming WH: Acute cardiac herniation following pneumonectomy. *Radiology* 120 : 546, 1976. PMID:948585

30-Johnson AS: Rupture of the pericardium with complete extrusion of the heart resulting from a steering wheel injury. *Am J Surg* 91 :605-610, 1956. PMID:13302568

31-Kageyama Y, Suzuki K, Matsushita K, Nogimura H, Kazui T. Pericardial closure using fascia lata in patients undergoing pneumonectomy with pericardiectomy. *Ann Thorac Surg* 1998; 66: 586–7 PMID:9725420

32-Junzo Shimizu, Yoshinori Ishida, Yasumitsu Hirano, Yasuhiko Tatsuzawa, Yukimitsu Kawaura, Akiko Nozawa, Keisuke Yamada, and Makoto Oda . Cardiac Herniation Following Intrapericardial Pneumonectomy with Partial Pericardiectomy for Advanced Lung Cancer. *Ann Thorac Cardiovasc Surg* 2003; 9: 68–72) PMID:12667133.

**Abbreviations:** Computed tomography (CT), extrapleural pneumonectomy (EPP), Intensive care unit (ICU), PCO<sub>2</sub> arterial carbon dioxide tension, PO<sub>2</sub> arterial oxygen tension.

---