Cardiac Herniation Following Extended or Radical Pneumonectomy—an Avoidable Complication?

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Abstract

Pericardial defects necessarily occur when the great pulmonary vessels are divided within the pericardial sac or when portions of the pericardium are resected because of direct tumor infiltration. As a result cardiac herniation or strangulation may develop if the heart prolapses through the surgically created defect in the pericardium.

In this report the authors present 5 cases of cardiac herniation following extended pneumonectomy. Herniation was left-sided in 3 of 5 patients; all instances occurred within the first twenty-four hours postoperatively. In 3 patients, the complication was associated with change in position for postural drainage, in 2 patients after massive coughing. The initial clinical picture was determined by sudden onset of low cardiac output, cyanosis, tachycardia, and asystole. All patients were reexplored without delay. The defects were covered with a substitute patch.

After the critical review of the literature and according to their own experience, the authors draw the following conclusions:

- **Sudden onset of low cardiac output without obvious signs of hemorrhage or cardiac failure is suspicious for cardiac herniation after pneumonectomy.**
- **Change in position onto the operated side, massive coughing, and large pericardium are the main risk factors.**
- **Emergency reoperation and reposition of the heart offers the only chance of survival.**
- **Cardiac herniation is most effectively prevented and can be avoided by patching the defect.**

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Presented at the 37th Annual Meeting, American College of Angiology, Atlanta, Georgia, October, 1990

Introduction

Pericardial defects necessarily occur when the great pulmonary vessels are divided within the pericardial sac, as in the resection of a central carcinoma with en bloc mediastinal dissection—called radical pneumonectomy[1]—or when portions of the pericardium are resected because of direct tumor infiltration, called extended pneumonectomy.[2] As a result cardiac herniation or strangulation may develop if the heart prolapses through the surgically created defect in the pericardium. This is a rare but highly dangerous complication. The goal of our report is to analyze the predisposing factors, and to describe the clinical picture and the methods of optimal prevention of cardiac herniation.

Patients and Clinical Features

After a review of 5 of our own patients and 49 patients of the literature we attempt to answer the question whether this complication after pneumonectomy can be avoided.

Initial Clinical Picture

During the past ten years 5 of our patients experienced cardiac herniation following extended or radical pneumonectomy. Squamous cell carcinoma of the bronchus was the reason for initial surgery in 3 patients, pleural mesothelioma in 1 patient, and mucoepidermoid carcinoma in 1 patient. The patients' age ranged between forty-three and sixty-four years. According to the new international staging system,[3] all patients were in stage IIIa, which means direct extension into the pericardium without involvement of the heart or great vessels. One patient had a T3 stage with extension into the mediastinal pleura. The ipsilateral hilar and subcarinal lymph nodes were involved in 3 patients. The main bronchus was infiltrated in all cases except the patient with pleural mesothelioma.

Initial Surgery

Three patients were treated with a left-sided extended or radical pneumonectomy and 2 patients with a right-sided radical pneumonectomy. The resultant pericardial defect was not repaired in 4 cases and was sutured with Vicryl in 1 patient.

Cardiac Herniation

Cardiac herniation occurred at the conclusion of the operation and in the early postoperative period between five and twenty-four hours. In 3 patients the complication was precipitated by change of the patient's position for postural drainage and in 2 patients by massive coughing. Sudden low output with profound hypotension and tachycardia were noted in 2 patients. Ventricular fibrillation was observed in 1 patient and sudden asystole in another. One patient with a patent foramen ovale experienced a sudden profound hypoxia without beneficial effect of oxygen administration. In retrospect this condition was due to a right outflow obstruction with a reversed pressure relationship between both atria.[4] In 4 of 5 patients an abnormal shift of the cardiac shadow was documented on chest x-ray.

Sites and Treatment

Emergency rethoracotomy was performed in each case. A strangulation of the prolapsed ventricles by the borders of the pericardial defect was observed in 3 patients with left-

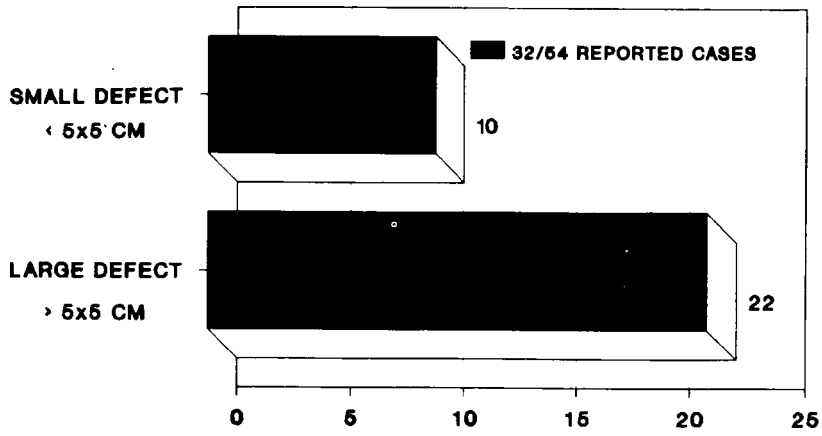

FIG. 1. Predisposing factors (size of pericardial defect).

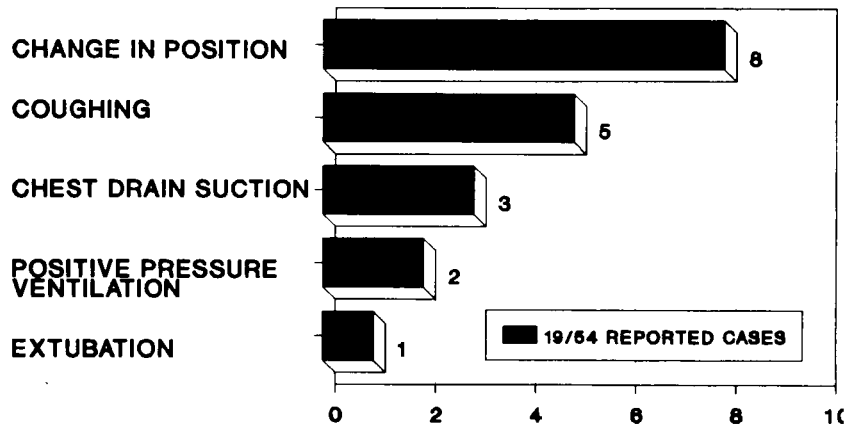

FIG. 2. Precipitating factors.

sided herniation. The hemodynamic and respiratory disturbances in 2 patients with right-sided herniation was due to a rotation of the dextroposed heart, resulting in superior inflow occlusion and ventricular outflow obstruction. The pericardial defect was closed with Teflon patch in 2 cases, with Vicryl patch in 2 cases, and with pleura in 1 patient. All 5 patients survived reoperation.

Discussion

In 1948 Bettmann and Tannenbaum[7] reported the first "Hernia pericardiaca postoperativa" after intrapericardial pneumonectomy. Since then, only 49 patients have been described in the literature, and half of them died.[4,6-21]

Concerning the 54 cases found in the English and German literature—including the 5 patients presented here—various predisposing and precipitating factors were observed. Large defects measuring more than 5 by 5 cm are twice as dangerous as smaller defects (Fig. 1). This fact was observed in all of our patients and in 32 reported cases with exact information.[4,6-21]

Only in 19 case reports have the precipitating factors been described exactly (Fig.2). Change in position to the operated side and massive coughing were the main risk factors for herniation in the early course after operation, as confirmed in our patients. Further factors have included the application of suction to the chest tube, positive pressure venti-

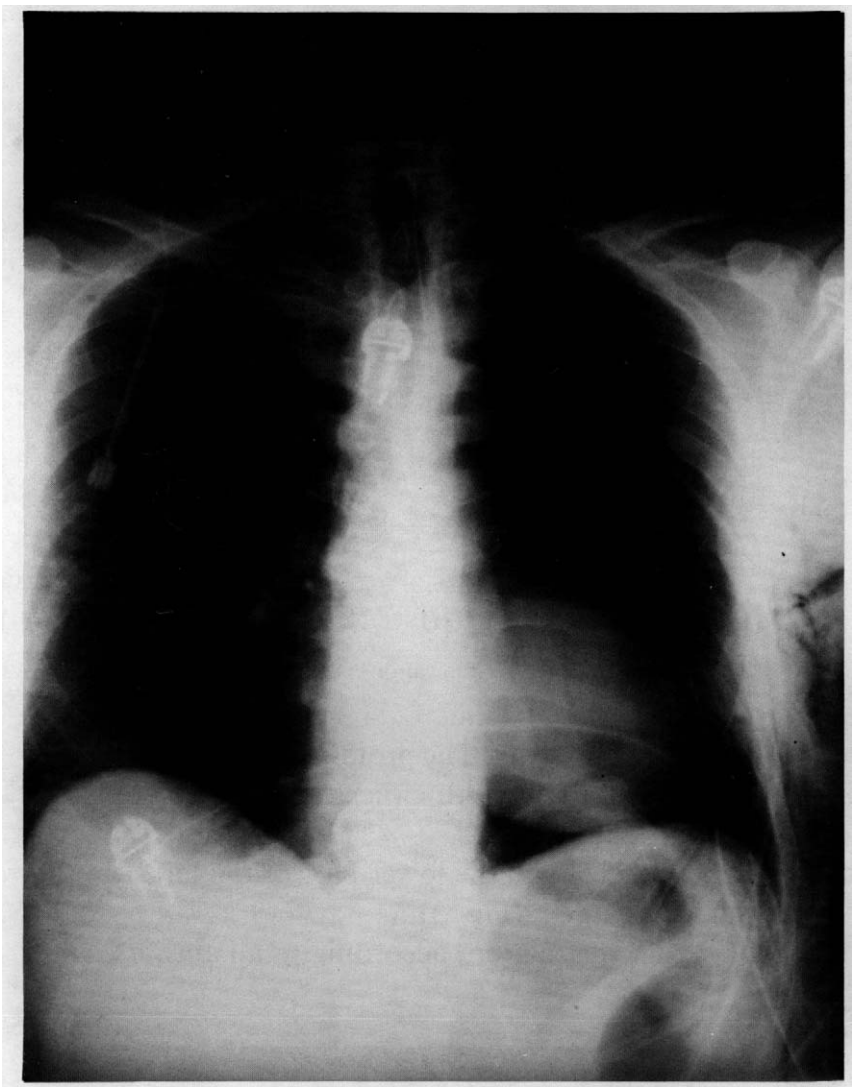

FIG. 3. Left-sided herniation.

lation of the remaining lung, and extubation.[4,6-21]

The sudden and dramatic onset of symptoms has appeared at the conclusion of the operation or in the early postoperative period, which means within the first forty-eight hours. However, Konrad [11] observed an individual case with cardiac luxation after the fourth postoperative day. The initial clinical picture was determined by sudden onset of low cardiac output with profound hypotension and tachycardia. Cyanosis, especially in the upper body, because of superior cava inflow occlusion with elevation of the jugular venous pressure was frequently noted, particularly in right-sided torsion of the heart. Ischemic ST changes in the electrocardiogram, sudden ventricular fibrillation, or asystole and other disturbances of the electrical axis are further signs of strangulated ventricles.

Some considerations in differential diagnosis are made necessary by the appearance of sudden low output or hypoxia in the early postoperative period.[22] Cardiac torsion must be differentiated from massive intrathoracic bleeding, atelectasis of the remaining lung or pneumothorax, acute pulmonary embolism, acute myocardial infarction, and cardiac tamponade.

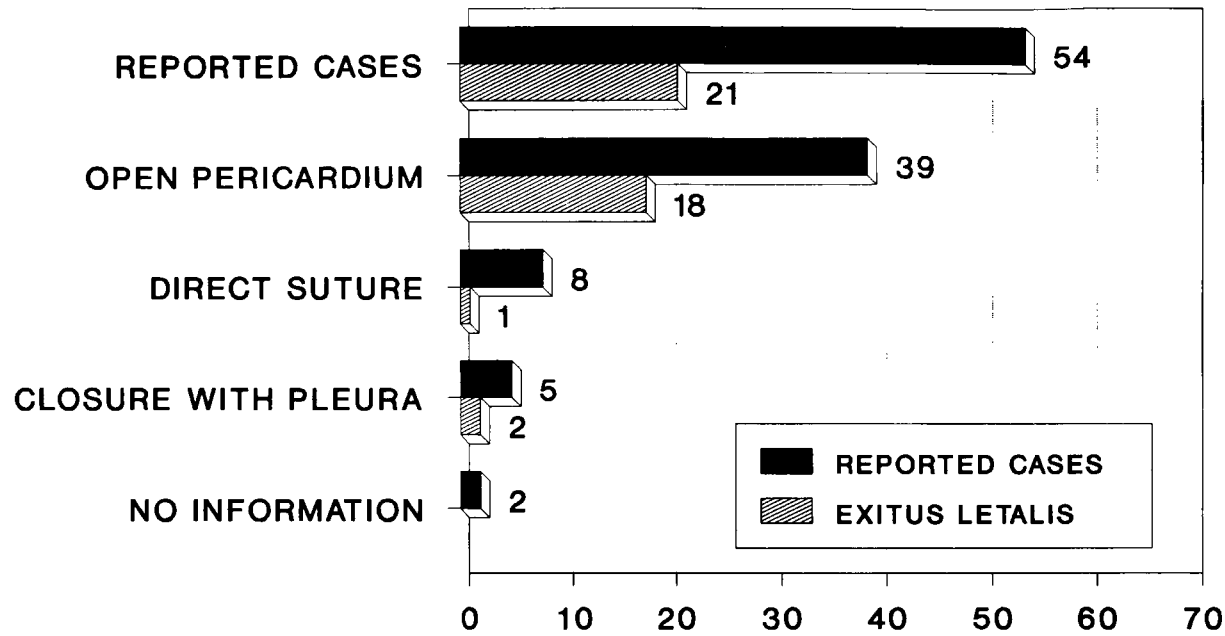

FIG. 4. Prophylactic measures against possible cardiac herniation after radical or extended pneumonectomy.

Right-sided herniation is easily recognized by x-ray. The prominent feature is the dextroposition of the heart into the right pleural cavity with either touching of the lateral chest wall or lateral-posterior twisting of the heart.

Left-sided herniation shows a rounded opacity in the lower part of the left hemithorax, owing to the left shift of the cardiac shadow (Fig. 3).

The only lifesaving treatment for cardiac herniation, according to all authors, is the

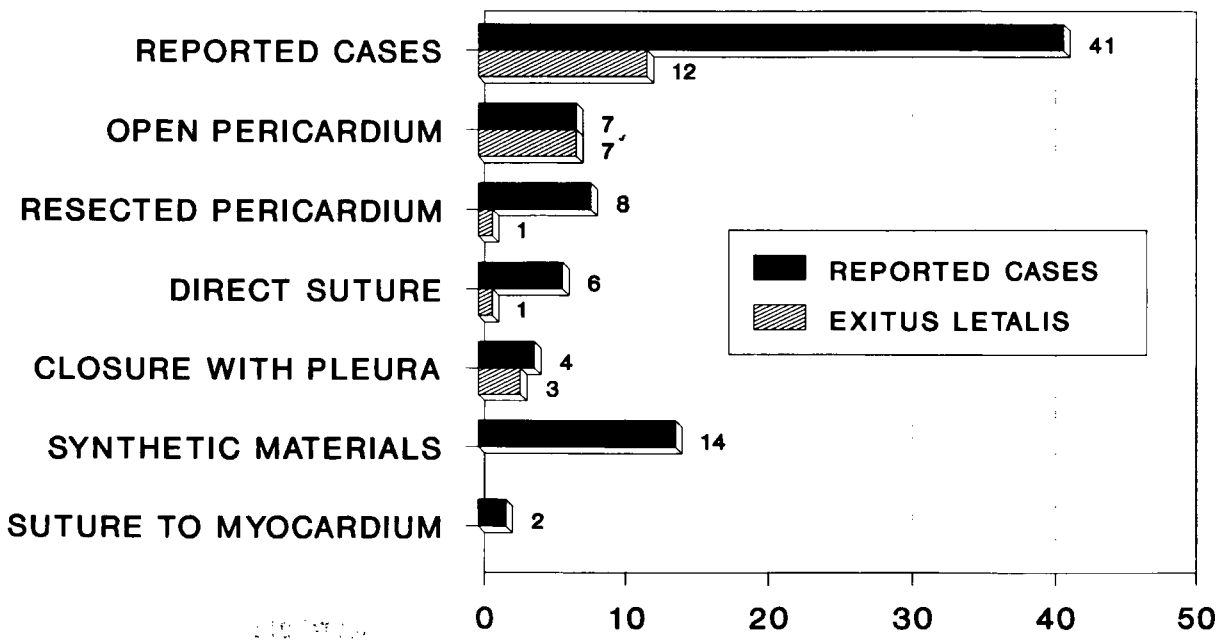

FIG. 5. Procedures after cardiac luxation.

immediate operative reexploration and reposition of the heart without delay.

Different prophylactic measures against possible herniation have been advocated (Fig.4). Of the 54 reviewed cases[4,6-21] the patent pericardium was not closed in 39 patients; 18 of them died because of cardiac luxation. In 5 patients the pericardium was closed with a substitute patch and 2 of the patients with a pleural flap died; in 8 patients a direct suture of the pericardium was applied with 1 death. In 2 cases no information was found.

The procedure after cardiac luxation has been described in 41 cases (Fig. 5). The pericardium was left open in 7 cases. All of these patients died owing to reluxation. The pericardium was totally resected in 8 cases and directly sutured in 6 cases. One patient in each group died. In 4 patients the defect was closed with a pleural substitute and 3 of them died owing to cardiac reluxation. No death and no other complications were reported in 14 patients treated by patching the defect with foreign materials (for example Teflon, Vicryl, or Dacron) and in 2 cases by suturing of the edges of the defect to the myocardium at 1 cm intervals, avoiding the coronary vessels. This method was described by Dippel and Ehrenhaft in 1973.[8]

Conclusion

Our results demonstrate that cardiac herniation is most effectively prevented and can be avoided by patching the defect with synthetic materials or by direct suturing of the margin of the defect to the epicardium,

Acknowledgments

We wish to thank Dr. D. Schmidle for documenting the case history from 2 patients.

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