Contralateral Pneumothorax after Pneumonectomy for Carcinoma

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Fortunately, contralateral pneumothorax occurs rarely after pneumonectomy. This complication was detected during the immediate postoperative period in four of 340 patients having pneumonectomy for carcinoma at the Ochsner Clinic from January 1942 through June 1958. To our knowledge delayed pneumothorax has not occurred in any of the remaining patients. This lends support to the impression that in these cases the pneumothorax is not truly spontaneous but is precipitated by some operative or postoperative condition, which may be apparent or may defy clarification even after reoperation or at necropsy.

The obvious compromise of pulmonary reserve incident to pneumonectomy renders such patients unusually vulnerable to pulmonary complications. For this reason, almost any complication of pneumonectomy may be a major one. The attending physician is constantly aware of the more common complications, such as pulmonary edema, excessive bronchial secretion, atelectasis, pneumonitis, congestive atelectasis, and tension hemopneumothorax of the operative side, whereas this rarer condition may be completely unsuspected. Pneumothorax has been reported as a complication of surgical procedures involving the neck,"¹ chest,"² subdiaphragmatic region"³ and abdomen."⁴ It has also complicated induced pneumothorax,"⁵"⁶ and pneumoperitoneum."⁷ Such an abnormal accumulation of air gains access to the pleural space by one or both of two ways: 1) through a defect in the respiratory tract or 2) through a defect in some structure in proximity to or in fascial plane continuity with the mediastinum and pleural spaces. There seem to be several possible sources and mechanisms of pneumomediastinum and pneumothorax after pneumonectomy: 1) Development of tension hemopneumothorax on the operated side by rapid accumulation of fluid in the pleural space. This may, at least theoretically, result in "driving" the air into the thoracic wall and mediastinum at sites of pleural disruption. 2) Tension pneumothorax may result from flutter valve type leakage of the sutured bronchial stump. 3) Leakage of the trachea, contralateral bronchus, or pulmonary parenchyma incident to operative injury. 4) Leakage of the contralateral pulmonary parenchyma, either from visceral pleural disruption or from disruption of alveoli within the pulmonary substance with extravasation of air to the surface of the lung, root of the lung, mediastinum, and pleural space. 5) Aspiration of outside air into the anatomic planes of the thoracic wall and mediastinum, either through a defect in the skin or perforation of the esophagus.

Because of the rarity of this complication, the four cases encountered at the Ochsner Clinic will be described in detail.

Report of Cases

CASE 1: A white man, aged 55 years, was seen June 6, 1947, complaining of pain in the left side of the chest, cough, anorexia, loss of weight, and easy fatigability of

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five months' duration. His illness had been attributed to a pulmonary lesion, which had been treated with roentgen rays without apparent benefit. The clinical and roentgenographic evidence was suggestive of bronchogenic carcinoma of the left upper lobe. Bronchoscopic biopsy failed to establish the diagnosis. The clinical impression that the patient could withstand left pneumonectomy was strengthened by the fact that he tolerated induction of left pneumothorax (1700 cc.) without difficulty.

At operation on June 14, 1947, a large carcinoma of the upper lobe of the left lung with extensive metastasis to the mediastinal lymph nodes was encountered. In the course of mediastinal dissection, during mobilization of a large retrotracheal node, the right pleural cavity was entered. The pneumonectomy was completed, after which the defect in the right mediastinal pleura was sutured and reinforced with absorbable gelatin sponge, and the sutured bronchial stump was covered with mediastinal pleura and areolar tissue. The thoracic wall was closed without drainage. Aspiration of the right pleural space yielded a small amount of air.

His condition was satisfactory at the conclusion of the operation, but during the ensuing three hours dyspnea and cyanosis became severe. Thoracentesis on the right side yielded a large amount of air and resulted in considerable improvement. Further respiratory distress occurred after three more hours. A catheter was inserted into the right pleural space. The next morning subcutaneous emphysema in the left side of the chest and both supraclavicular areas was present. Severe mediastinal emphysema and right pneumothorax were demonstrated in a roentgenogram of the chest (Figure 1a). There was no evidence of a fluid level in the left hemithorax. After placement of a second tube in the right pleural space, the pneumothorax was controlled, the interstitial emphysema subsided, and he improved steadily. The right lung was clear and fully expanded by the 10th postoperative day, when he was discharged from the hospital in satisfactory condition (Figure 1b).

![Figure 1a](http://journal.publications.chestnet.org/pdfaccess.ashx?url=data/journals/chest/21338/)

**FIGURE 1a:** Case 1. There is residual right pneumothorax after insertion of a single tube. The left hemithorax contains air and extensive interstitial emphysema of the thoracic wall is present. **FIGURE 1b:** A roentgenogram of the chest on the tenth postoperative day shows complete reexpansion of the right lung, obliteration of the left pleural space by effusion and subsidence of the interstitial emphysema.

**Comment:** The likelihood that the preoperative left pneumothorax had any relation to the development of interstitial emphysema and right pneumothorax seems to be remote. Opening of the right pleural space during mediastinal dissection resulted in development of right pneumothorax and necessitated use of increased positive pressure anesthesia until the defect was closed. The minimum accumulation of fluid on the operative side militates against the possibility of displacement of the trapped air in the left hemithorax as the source of the right pneumothorax. Furthermore, the need for thoracentesis and catheter drainage, and the severe interstitial emphysema are convincing evidence that there was an active leak from the tracheobronchial tree during the postoperative period. There was nothing in the postoperative course to suggest a fistula from the bronchial stump or an injury to the trachea. The occurrence of interstitial pulmonary emphysema in the right lung would seem to be the most likely cause of the pneumothorax and severe degree of interstitial emphysema.
CASE 2: A white man, 49 years old, had an asymptomatic lesion in the right lung that was detected seven months previously during roentgenography of the chest incident to an examination after an automobile accident. The progress of the lesion was followed by serial roentgenography. In the roentgenogram taken the day before admission the lesion was found to have doubled in size. A peripheral type bronchogenic carcinoma was the presumptive diagnosis; in addition, the patient had clinical evidence of emphysema with increased anteroposterior diameter of the chest and kyphosis. Pulmonary function studies indicated that the patient could withstand a major surgical procedure.

On August 13, 1952, at thoracotomy the diagnosis of bronchogenic carcinoma was confirmed and right pneumonectomy was performed without incident. The immediate postoperative reaction was good. The patient's condition was satisfactory at the time of morning rounds on the first postoperative day. Later that morning signs of respiratory difficulty developed, with cyanosis, dyspnea, and an increase in respiratory rate to 40 per minute. On examination of the chest at this time, the left lung was "clear." Repeated attempts to clear the airway by tracheal suction yielded only small amounts of mucus. The respiratory distress became more and more severe and the patient died in mid-afternoon.

At necropsy the left pleural cavity contained a large amount of air and the left lung was completely collapsed except for a small area in the left apex. Residual tumor was found in one mediastinal node and in one small area in the liver. The lesion in the resected lung proved to be adenocarcinoma with mediastinal node metastasis.

Comment: The first suggestion of respiratory distress appeared almost 24 hours after operation and proved to be due to tension pneumothorax. There was no clinical or postmortem evidence of interstitial emphysema and no bullae were described in the resected lung or in the remaining lung at necropsy. In spite of this, a defect on the surface of the lung would best explain this series of events. Roentgenography of the chest was not performed during the postoperative period.

CASE 3: A man, aged 65 years, complained of hemoptysis of two months' duration. Serial roentgenograms of the chest showed no abnormality until the one taken just before he came to the clinic, in which right hilar enlargement was noted. Roentgenography of the chest at the clinic confirmed this and indicated probable bronchogenic carcinoma. Results of examination of the sputum and bronchoscopic biopsy were not diagnostic. After demonstration of satisfactory pulmonary function, exploratory thoracotomy was performed on April 9, 1956. The histologic diagnosis was epidermoid bronchogenic carcinoma with extensive involvement of the mediastinal nodes.

Immediately after radical right pneumonectomy, hypotension, tachypnea, tachycardia, and extreme restlessness developed. Because the 1500 cc. of blood given during the operation was considered insufficient, an additional 1000 cc. was given. Also, an infusion containing norepinephrine was started. A portable roentgenogram of the chest, made the evening of operation, revealed the right hemithorax to be about 75 per cent opacified by accumulation of intrapleural fluid, and considerable interstitial...
emphysema in both supraclavicular regions and in the right thoracic wall. The left lung appeared to be clear in spite of diminished breath sounds, wheezing and rales at the base and in the lateral thoracic region. At bronchoscopy the tracheobronchial tree contained no significant amount of secretion and the closure of the bronchial stump was intact. An electrocardiogram was similar to the one taken preoperatively. The patient remained in critical condition throughout the night and into the following day, when roentgenography of the chest indicated considerable change (Figure 2a). There was left pneumothorax with shift of the heart and mediastinum to the right in spite of a large amount of fluid in the pleural space. A catheter was inserted into the left pleural space by closed thoracotomy with immediate, almost complete, resolution of the pneumothorax. Thereafter, his condition improved rapidly and by the second postoperative day the left pneumothorax was completely relieved (Figure 2b). Convalescence was satisfactory until the sixth postoperative day, when cardiac and respiratory difficulties suddenly developed. The patient had severe bronchospasm, profuse tracheobronchial secretion, labored respiration and tachycardia. There was no clinical or roentgenographic evidence of bronchial leakage or of collapse of the left lung. He rapidly lapsed into coma and died.

At necropsy atherosclerosis of the coronary arteries with recent thrombosis of the right coronary artery, early bronchopneumonia secondary to aspiration, and partial congestive atelectasis of the left lung was found. The bronchial stump was intact; no pneumothorax or residual tumor was demonstrated.

Comment: The extensive interstitial emphysema and pneumothorax suggest an active leak from the respiratory tree rather than passive displacement of trapped air from the opposite side. The thrombotic change in the diseased coronary vessel was most probably precipitated by the state of shock during the immediate postoperative period.

CASE 4: A white farmer, aged 48 years, came to the clinic on May 3, 1956, for evaluation of an illness that began with pleuritic pain in the left side of the chest and hemoptysis three years earlier. There had been repeated clinical and roentgenographic evidence of disease of the left lower lobe of the lung. A trial of antituberculous therapy had been ineffective.

After establishment of a diagnosis of bronchogenic carcinoma of the left lower lobe by bronchoscopy and demonstration of satisfactory pulmonary function to withstand pneumonectomy, thoracotomy was performed on May 9, 1956. Palliative radical pneumonectomy was performed, since the tumor had metastasized to the hilar and mediastinal lymph nodes.

The postoperative course was satisfactory. The right lung was considered normal on clinical examination, although he thought he had slight difficulty in breathing. Roentgenography of the chest was performed on the fifth postoperative day (Figure 3a). There was an estimated 25 per cent collapse of the right lung by pneumothorax with shift of the heart and mediastinum to the left, although the left pleural space

![FIGURE 3a](image1)

![FIGURE 3b](image2)

FIGURE 3a: Case 4. Roentgenogram taken on the fifth postoperative day shows estimated 25 per cent collapse of the right lung. There is no interstitial emphysema and the mediastinum is shifted toward the operative side. FIGURE 3b: Two days after aspiration of 450 cc. of air from the right pleural space only a thin rim of air remains over the apex and the right border of the mediastinum is evident.
was almost completely filled with fluid. The dyspnea was relieved by thoracentesis with removal of 450 cc. of air from the right pleural space. Roentgenography of the chest 48 hours later showed only a thin rim of air over the right apical region (Figure 2). He was discharged on the ninth postoperative day.

Comment: A small amount of crepitation is sometimes detected about the operative wound during the first few days after pneumonectomy. The usual explanation for this is the development of some degree of tension in the residual air in the hemithorax from which the lung has been removed, with extravasation of air into the tissues adjacent to the wound. The roentgenogram of the chest made on the fifth postoperative day demonstrated, in addition to the mild, right pneumothorax, that the left pleural space had already been almost obliterated by accumulation of fluid. Although the opposite pleural space had not been grossly opened, the nodal dissection incident to radical pneumonectomy certainly exposed the opposite pleura at multiple sites. Perhaps the strongest objections to displacement of trapped air from the operative side as a possible explanation for this mild degree of pneumothorax are: 1) the mediastinum was shifted toward rather than away from the operative side, and 2) the fact that one frequently sees the hemithorax fill with fluid in a short time and one rarely sees contralateral pneumothorax.

Discussion

Ten cases of contralateral pneumothorax in the immediate period after pneumonectomy have been found in the medical literature.2,4-7,10-11 A ruptured bleb or bulla was demonstrated in 6 of these 10 cases2,4,7,10 and was suggested as the probable cause in three of the remaining 4 cases.12 In the other case it was thought that there had possibly been a communication through the mediastinum, but such a defect was not demonstrated at necropsy.1 One case of contralateral pneumothorax that occurred 60 days after pneumonectomy was reported by Melick and Gutekunst.1 Only two of these 11 patients survived.1,4

Persistence of the leakage in Cases 1 and 3 and the high degree of tension in Case 2 must undoubtedly be attributed to an active leak in the respiratory tree. The extensive supraclavicular and thoracic wall interstitial emphysema in Cases 1 and 3 are more in keeping with disruption within the pulmonary parenchyma, whereas the small interstitial extravasation in Cases 2 and 4 could be explained by a defect on the surface of the lung. No evidence of leakage at the suture line of the bronchial stump or of injury to the structure of the major airway was demonstrated in the two cases in which necropsy was performed, nor could such leakage be suspected by the subsequent course of the two surviving patients. Therefore, it seems most probable that the leak occurred at the parenchymal level. A ruptured bulla would be the most direct and easily understood mechanism of this occurrence. However, there was no mention of evidence of bullae in any of the four lungs removed at operation or of the two examined at necropsy. The other surface abnormality, the subpleural bleb, is the surface evidence of interstitial pulmonary emphysema so convincingly substantiated by the work of Macklin and Macklin.12 This concept is strengthened by Dickie's7 study of cases of spontaneous pneumothorax. The bleb is evidence that some disruption in the lining of the respiratory parenchyma has occurred and that the extravasation of air occurs medially to the mediastinal pleura as well as peripherally to the visceral pleura. Further, Macklin and Macklin showed that once a site of leakage has developed, the leak can be maintained by considerably lower pressure than is necessary to produce the original diaphragm. It has been shown that lungs confined to their normal volume can withstand a considerably higher intrapulmonary pressure before leakage occurs than can a lung which can be distended beyond its optimum volume.19 Some degree of at least intermittent over-expansion of the opposite lung must occur in virtually every open thoracotomy provided the mediastinum is mobile.

The cases of pneumothorax herein presented can hardly be considered as "spontaneous" but rather seem to be in some way precipitated by conditions existing within the pulmonary tissue during or after pulmonary operations. Furthermore, these conditions seem to result from altered pulmonary mechanics associated with these types of operations, as pneumothorax attributed to this mechanism, that is, interstitial pulmonary emphysema incident to extrathoracic operations, appears to be extremely rare.

Macklin12 suggested that a local area of tension might be built up beyond a bronchial plug producing a ball-valve effect. Such a local mechanism could occur while normal pressure conditions existed in the major portion of the pulmonary system and could explain the occurrence of pneumothorax with the subject at complete rest. In view of the wide range of variations in volume to which the lung is subjected during and after operation, and considering the great number of thoracotomies that have been performed, one wonders at the rarity of this complication. The operative and postoperative courses of patients undergoing pulmonary resection are remarkably similar that from one patient to the next it is difficult or impossible to single out any variation in these patients to account for this rare complication. In the absence of a gross site of leakage one seems forced to attribute this complication to disruption of the pulmonary parenchyma. In the presence of a mobile mediastinum in cases of open thoracotomy the contralateral lung is fre-
sequently distended beyond its optimum volume. Such overexpansion at normal or increased intrapulmonary pressure would seem to be a likely explanation for parenchymal disruption.

**SUMMARY**

Contralateral pneumothorax is one of the rarer complications of pneumonectomy. For such cases among 340 pneumonectomies for carcinoma at the Ochsner Clinic and 11 cases found in the literature indicate that this complication in itself should be completely correctable in most instances if recognized promptly and the pneumothorax relieved. The source of the pneumothorax is most probably a pulmonary parenchymal disruption, either within the pulmonary substance or on the surface of the lung.

**RESUMEN**

El neumotórax contralateral es una de las más raras complicaciones de la neumonectomía. En la clínica Ochsner entre 340 neumonectomías por carcinoma, se encontraron cuatro casos y 11 más en la literatura, indican que esta complicación debe ser completamente corregible en la mayoría de los casos si se reconoce pronto y se trata el neumotórax.

La causa del neumotórax es lo más probable una ruptura del parénquima pulmonar ya sea dentro de la masa pulmonar o en la superficie.

**RESUMÉ**

Le pneumothorax contralatéral est une des plus rares complications de la pneumonectomie. Quatre cas de ce type sur 340 pneumonectomies pour cancer à la Clinique Ochsner, et II cas trouvés dans la littérature montrent que cette complication devrait être en elle-même complètement curable dans la plupart des cas si elle est reconnue rapidement et si on supprime le pneumothorax. L'origine du pneumothorax est le plus vraisemblablement une rupture parenchymateuse pulmonaire soit dans la profondeur du parenchyme pulmonaire soit à la surface du poumon.

**ZUSAMMENFASSUNG**


Die Herkunft des Pneumothorax ist höchstwahrscheinlich ein pulmonaler Parenchymriss, entweder im Lungeninneren oder an ihrer Oberfläche.

**REFERENCES**

CONTRALATERAL PNEUMOTHORAX


