Thoracoscopic Management of Spontaneous Pneumothorax*

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Modern thoracoscopy currently allows minimally invasive access to the chest cavity with the ability to assess and treat a wide variety of intrathoracic lesions. Spontaneous pneumothorax is a common ailment occurring in 9 patients per 1,000 persons per year.1 Pneumothorax is usually treated with tube decompression, often followed by chemical pleurodesis. Recurrence or persistent air leak requires formal surgical therapy. Traditionally, this has involved thoracotomy with resection of visible parenchymal blebs and mechanical pleurodesis or pleurectomy. While formal thoracotomy is associated with a low recurrence rate, the morbidity and disability remain formidable. Thoracoscopy allows full visualization of the lung and pleura and, when combined with a resection of blebs and pleurodesis or pleurectomy, results in a low recurrence rate, minimal patient discomfort, and rapid recovery. We will describe six patients treated for spontaneous pneumothorax and discuss current thoracoscopic treatment options.

Materials and Methods

Patients

Case 1: A 22-year-old black woman was admitted for her first spontaneous pneumothorax. Initially treated with tube decompression, she continued to have an air leak for 7 days. Thoracoscopy was performed, and staple resection of what appeared to be a collapsed bleb was performed. Pleurodesis with electrocautery was also done. Postoperatively, she developed another air leak and was returned to the operating room on postoperative day 10 for a limited thoracotomy and apical pleurectomy. Pathologic examination of the lung tissue was consistent with interstitial pulmonary fibrosis. She did well and was discharged 4 days later.

Case 2: A 24-year-old black woman presented with her second spontaneous pneumothorax. Initial tube decompression reinflated the lung. She underwent thoracoscopy with apical blebectomy using an endoscopic stapler. Chemical pleurodesis was performed with doxycycline, and a partial pleurectomy of the apex was done. Postoperative recovery was uneventful, and she was discharged on postoperative day 2. (This woman has a brother who underwent thoracotomy and pleurectomy 1 year previously. He was discharged on postoperative day 7).

Case 3: An 18-year-old white man with a history of asthma presented with a fourth spontaneous pneumothorax on one side. He previously had two pneumothoraces on the other side. He underwent a thoracoscopic resection of multiple blebs using the endoscopic linear stapling device. Chemical and mechanical pleurodesis was performed with the use of a "home-made" endoscopic Kittner dissector and doxycycline. He was discharged on postoperative day 3.

Case 4: A 20-year-old white man presented with his second right-sided pneumothorax. Previously he had developed a contralateral pneumothorax, which was treated with tube decompression. Thoracoscopic bleb resection and chemical and mechanical pleurodesis using doxycycline were performed. Apical pleurectomy, using electrocautery dissection, was included. He did well and was discharged on postoperative day 2.

Case 5: A 23-year-old white man had a history of multiple bilateral pneumothorax and previously treated with tube thoracotomy. Tube thoracotomy failed to fully reexpand his lung. Thoracoscopy allowed lysis of multiple pleural adhesions and resection of several apical blebs using the linear stapler. The apical pleura was removed, and chemical pleurodesis with doxycycline was performed. The patient had an air leak postoperatively, which resolved by postoperative day 6, and he was discharged thereafter. He was able to return to school the following week.

Case 6: A 36-year-old black male veteran presented with acute shortness of breath. Five years previously, he had had a spontaneous pneumothorax, which was treated with chest tube decompression. The initial chest radiograph revealed a giant bleb and pneumothorax. He exhibited a persistent air leak. Thoracoscopy revealed a giant bleb occupying most of the left chest cavity. This was excised using a combination of linear stapling and electrocautery. Intraoperative bronchoscopy with instillation of methylene blue was done to identify the source of the air leak and to ensure its disappearance. Apical pleurectomy was performed, and the patient was discharged on postoperative day 3.

Operative Technique

General anesthesia is used with double-lumen endotracheal intubation. Invasive monitoring devices are placed as indicated for thoracotomy. The patient is positioned in the lateral decubitus position. Two video monitors are used, one near the foot of the bed and the other placed over the patient's head. After instituting single-lung ventilation, pneumothorax, if not already present, is established with a Verres needle opened to air or to a positive pressure of less than 10 mm Hg.

The surgeon, standing posterior to the patient, places three trocars initially. The camera is placed via the sixth intercostal space in the posterior axillary line. A 12-mm port is placed in the fifth intercostal space at the anterior axillary line, and an additional port is placed via the seventh intercostal space in the midaxillary line. Full visualization can be ensured by use of the 0° and 30° telescopes.
Careful inspection of the chest cavity and lung, including lysis of adhesions, should be performed. Linear stapling devices can be introduced via the large port, and the electrocautery can be used for pleurectomy as indicated. Care should be taken to avoid major vascular and neural structures. Postoperative chest tube placement should be via the anterior port site. All port sites should be closed in two layers.

**DISCUSSION**

Spontaneous pneumothorax can be classified as primary or secondary depending on its etiology. Primary spontaneous pneumothorax occurs in 25- to 30-year-old otherwise healthy patients, who often have a history significant for smoking, previous pneumothorax, or family members with pneumothorax. The pneumothorax occurs as a result of rupture of individual alveoli causing subpleural blebs and pneumothorax. This is in contrast to secondary spontaneous pneumothorax, which results from progressive destruction of distended alveolar walls causing formation of blebs, which rupture and cause pneumothorax. Secondary pneumothorax occurs in 45- to 60-year-old patients, many of whom have underlying chronic lung disease.

Diagnosis is confirmed in both groups by chest radiographic evidence of pneumothorax. Initial treatment is tube decompression, which should be carefully monitored to ensure full expansion of the lung. After the initial treatment, 2 to 3 percent of patients will develop a chronic air leak, and approximately 40 to 50 percent will develop a recurrent pneumothorax.

Further treatment is then indicated for recurrent pneumothorax, for chronic air leak, or following the initial event in patients who live in a remote area or participate in high-risk activities. Chemical sclerotherapy is the most frequently utilized secondary treatment. A wide variety of agents have been used with varying success. Disadvantages include technical difficulty in instillation, severe pain, and a significant rate of recurrence. Previously, thoracotomy with or without resection of visible blebs with mechanical pleurodesis had been the mainstay of definitive therapy, with a recurrence of 2 to 5 percent. Pleurectomy can be added, reducing the recurrence rate to less than 1 percent. Morbidity with this therapy is significant and can become prohibitive, especially in the older patient population with underlying lung disease.

Thoracoscopy is a unique way to avoid the morbidity of thoracotomy and definitively treat spontaneous pneumothorax. As a diagnostic implement, magnified direct visualization of all lung surfaces can be performed to evaluate the lung for parenchymal disease. Techniques to detect air leaks, such as partial lung inflation and inflation with the lung immersed, can be

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**FIGURE 1.** Bleb after partial excision with linear stapling device.

**FIGURE 2.** Adhesions between chest wall and lung being divided with scissors.

**FIGURE 3.** Kittner dissection being used for mechanical pleurodesis. Partial pleurectomy has been performed at the apex of the pleural space.
used to help find small air leaks. When identified, these can be dealt with appropriately.

It seems logical that the primary therapeutic approach for pneumothorax should be to treat the lung, the source of the pneumothorax, first. Identified bullae can be treated with a variety of modalities. Ablation with electrocautery or laser has been reported with some success.\(^8\) Ligation of individual bullae with sutures also has been reported.\(^9\) Complete excision and stapling of the base of the bleb with an endoscopic linear stapling device (Fig 1) appears to be the most successful technique and was utilized in all of our cases.\(^10\) In addition, this modality provides a specimen of lung parenchyma for pathologic diagnosis. Areas of the lung without large bullae but with multiple small bullae can easily be excised with a stapling device.

Recurrent spontaneous pneumothorax is prevented by causing a permanent symphysis between the visceral pleura and the interior of the chest wall. This can be accomplished thoracoscopically by a wide variety of techniques and agents. Initially, residual adhesions should be divided between the pleurae to allow full expansion of the lung (Fig 2). Mechanical pleurodesis can be accomplished with direct physical trauma to the parietal pleura (ie, with the Kittner dissector introduced via the thoracoscope) (Fig 3). The pleura can be abraded or incised using the electrocautery or laser. Chemical pleurodesis can be introduced via the thoracoscope when appropriate. Talc poudrage has been advocated by some, but the availability is limited and preparation remains tedious.\(^11,12\)

Parietal pleurectomy historically has been associated with the lowest incidence of recurrent pneumothorax. Thoracoscopic parietal pleurectomy is easily accomplished under direct vision with minimal blood loss when performed with electrocautery. Resection of the apical pleura ensures adhesions of the expanded lung in the region of likely recurrent bleb disease.

In our series, the patient in case 1 was the first ever treated with the thoracoscopic stapling device. Although electrocautery pleurodesis was done, this modality has since been shown to be less than perfect.\(^12\) We have had no recurrences with thoracoscopic stapling, partial pleurectomy, and instillation of doxycycline.

Thoracoscopy provides the surgeon with a modality that can safely and definitively treat spontaneous pneumothorax. Complete magnified visualization of the lung and the pleural surface can be accomplished. Excision of bleb disease with the linear stapling device definitively and successfully treats and allows pathologic diagnosis of these lesions. Mechanical and chemical pleurodesis combined with apical pleurectomy ensures a low recurrence rate. Postoperative discomfort and respiratory complications are minimal, and a rapid return to full activity follows thoracoscopy. Current prospective multi-institutional trials should establish these advantages and may identify thoracoscopic treatment of spontaneous pneumothorax as the ideal modality for cure.

REFERENCES