Postpneumonectomy Syndrome*

Recognition and Management

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Study objective: Postpneumonectomy syndrome (PPS) results from extreme shift and rotation of the mediastinum after pneumonectomy producing symptomatic proximal airway obstruction and air trapping. Herein, we review our experience in the treatment of PPS.

Patients: Five patients with PPS were treated at our institution between 1991 and 1997. Four patients had previous right pneumonectomy; one patient had left pneumonectomy. Dyspnea was the presenting symptom in all five patients. The time interval to onset of symptoms and to surgical correction ranged from 6 months to 9 years (median: 6 months) and 9 months to 29 years (median, 21 months) after pneumonectomy, respectively.

Intervention: The clinical diagnosis of PPS was confirmed with chest radiograph, two-dimensional echocardiography, pulmonary function tests, CT scan, and awake fiberoptic bronchoscopy. Correction of PPS required reexploration of the pneumonectomy space followed by anterior pericardiorrhaphy and insertion of a saline solution-filled Silastic prosthesis (Dow Corning; Midland, MI) for the purpose of correcting the overshift of the mediastinum. There was no morbidity or mortality.

Results: All patients had relief of dyspnea. Corrective repositioning of the mediastinum was confirmed by chest radiograph, CT scan, and awake fiberoptic bronchoscopy. There was a mean increase in the cross-sectional diameter, as measured by CT scan, of the obstructed bronchus by 166.7% (range, 100 to 300%) in four patients. One patient had no change in the measured diameter. Postoperatively, the peak expiratory flow rate increased by a mean of 44.2% (range, 40 to 49%) in all five patients.

Conclusion: The presence of PPS should be considered in all patients presenting with progressive dyspnea after pneumonectomy. Repositioning of the mediastinum with a saline solution-filled prosthesis and anterior pericardiorrhaphy is easily performed and provides immediate and lasting symptomatic relief.

(CHEST 1998; 114:1766–1769)

Key words: bronchial obstruction; postoperative complication; postpneumonectomy syndrome

Abbreviations: PEFR = peak expiratory flow rate; PFT = pulmonary function test; PPS = postpneumonectomy syndrome

Proximal bronchial obstruction occurring after pneumonectomy can result from excessive mediastinal shift and rotation. This condition is referred to as postpneumonectomy syndrome (PPS). PPS has been described mostly in infants and young adults but there have been multiple case reports occurring in adults.

Clinically, patients present with progressive dyspnea, stridor, and recurrent pulmonary infections. Diagnosis is based on chest radiography, CT scan, and awake fiberoptic bronchoscopy. However, one must rule out other causes of dyspnea in these patients, including recurrence of malignancy, pulmonary hypertension, progression of underlying lung dysfunction, recurrent thromboembolism, and congestive heart failure.

Herein we present our results in the management of PPS and a review of the literature.

Materials and Methods

Between 1990 and 1997, five patients were recognized to have PPS at our institution. All patients underwent extensive preoperative evaluation to rule out other causes of dyspnea, including progressive emphysema and pulmonary hypertension. In addition to history and physical examination, patients underwent complete pulmonary function tests (PFT), chest radiography, CT scan, two-dimensional echocardiogram, and awake fiberoptic bronchoscopy to confirm the diagnosis. In cases of prior malignancy, a bone scan was also performed as part of the metastatic workup.

After a diagnosis of PPS was confirmed, the patients were offered surgical treatment.

With the patient under general anesthesia and full monitoring capacity using a radial arterial line, ECG monitoring, Foley catheter, pulmonary artery balloon catheter, and thoracic epidural catheter, the patient was prepared for lateral thoracotomy.

The previous incision was reopened. In two patients, there was a suction noise immediately on entering into the pneumonectomy space causing the mediastinum to fall away from the posterolateral chest wall; there were no adhesions found. In the remaining three patients, the mediastinum was adherent to the chest wall requiring lysis of adhesions. After complete mobilization of the mediastinum, anterior pericardiorrhaphy was performed, anchoring the pericardium to the parasternal chest wall using non-

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Manuscript received February 23, 1998; revision accepted May 13, 1998.

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absorbable suture. A saline solution-filled Silastic prosthesis (Dow Corning; Midland, MI) was then placed to maintain the mediastinum in a balanced position; overcorrection was avoided by constant hemodynamic monitoring and frequent endoscopic assessment. Serial chest radiographs were performed after the operation to monitor the position of the mediastinum.

All patients have been followed up since their operation. They have had repeated chest radiograph, CT scan, and PFTs within the first 3 months following correction. To determine the success of the operation, we have looked at the following variables: subjective improvement in dyspnea, the ratio of FEV1/FVC, percent change in peak expiratory flow rate (PEFR), and percent change in cross-sectional diameter of the obstructed bronchus. The latter measurements were obtained at the point of minimal bronchial diameter on CT scan at usual lung windows (window length, 500; window width, 1,500) with 5-mm slice thickness.

**RESULTS**

The mean age of the five patients at pneumonectomy was 46.4 years (range, 21 to 72 years). The mean age at correction of PPS was 53.8 years (range, 22 to 74 years). The underlying reasons for pneumonectomy were non-small cell bronchogenic carcinoma in three patients, carcinoid in one patient, and hypoplastic lung in one patient. The time interval from pneumonectomy to onset of symptoms of PPS ranged from 4 months to 9 years (median, 6 months). All five patients complained of disabling dyspnea. None of the patients had stridor or recurring pneumonia. The clinical diagnosis of PPS was confirmed with PFTs, chest radiography, CT scan (Fig 1, top, and Fig 2, left) and awake fiberoptic bronchoscopy in all patients. PFTs revealed an obstructive pattern with a decrease in FEV1/FVC and PEFR. Chest radiograph showed hyperinflation of the remaining lung and complete shift of the mediastinum into the pneumonectomy space. In addition to plain radiographic findings, CT scan confirmed the presence of severe extrinsic compression of the bronchus. Two-dimensional echocardiography was performed to rule out pulmonary hypertension and cardiac dysfunction as causes for dyspnea. The time interval from pneumonectomy to surgical correction of PPS ranged from 9 months to 29 years (median, 21 months).

The operation was performed without morbidity or mortality. Follow-up is complete. Repositioning of the mediastinum was confirmed by chest radiograph, CT scan (Fig 1, bottom, and Fig 2, right), and awake fiberoptic bronchoscopy. Clinically, all patients have had relief of dyspnea. The objective measures of improvement in dyspnea are listed in Table 1. Postoperative PFTs have shown a mean increase in the PEFR of 44.4%. The FEV1/FVC increased by a mean of 13.2%, although one patient showed a decrease by 2%. There was a mean increase in the cross-sectional diameter of the obstructed bronchus of 133.4% as demonstrated by CT scan. All patients have shown an objective improvement in at least two of these measured variables.

Follow-up ranged from 7 months to 6 years. All patients are alive and well. Patient 5 has had a decompress of his prosthesis 3 years postcorrection. However, he remains symptom free with no evidence of recurrence of PPS on chest radiography or on CT scan.

**DISSCUSSION**

PPS is an uncommon occurrence. If the mediastinum does not stabilize after pneumonectomy, it can shift excessively toward the empty hemithorax. This results in hyperinflation of the remaining lung with counterclockwise (after right pneumonectomy) or clockwise (after left pneumonectomy) rotation. The trachea and mainstem bronchi are stretched and come to lie in the contralateral paravertebral gutter. As a result, compression of the main bronchus occurs between the left pulmonary artery and aorta (right PPS, Fig 1, left) or between the right pulmonary artery and the thoracic spine (left PPS). In a left PPS, contrary to the previous belief that a right-sided aortic arch was a prerequisite, it has been shown that PPS can occur with a left-sided aortic arch.1-3 We believe that there is elongation and narrowing of the bronchus intermedius down to the origin of the middle lobe bronchus secondary to distortion of the right hilum from the anterolateral pulling effect caused by the posterolateral displacement of the mediastinum and herniation of the lung across the midline. Our patient 5 developed left PPS with a left-sided aortic arch. Although PPS occurs more commonly in the younger age group because of increased elasticity and compliance of
the remaining lung and mediastinum, there have been at least 26 cases described, in addition to our own, in adults.

The patients with PPS present with dyspnea, stridor, and recurring pneumonia. These symptoms may occur weeks to years after pneumonectomy. Diagnosis is made from chest radiograph, CT scan, PFT results, and awake fiberoptic bronchoscopy. Hyperinflation and herniation of the contralateral lung along with extreme deviation of the trachea are seen on chest radiograph; however, bronchial narrowing cannot be appreciated on plain radiographs. CT scan will demonstrate the level and extent of bronchial narrowing as well as rule out recurrence of malignancy. Bronchial obstruction leads to a decrease in flow rates and air trapping. Therefore, there will be a decrease in PEFR and FEV₁/FVC ratio on lung function testing. Awake fiberoptic bronchoscopy will reveal dynamic obstruction of the affected bronchus. If the bronchial obstruction is long standing, tracheobronchomalacia is a concern, but there is no specific test that can predict its presence in this setting.

There have been many case reports in the adult and pediatric literature on PPS. Because of the rarity of the condition, a number of different treatment options have been described. Maneuvers such as division of the ligamentum arteriosum,⁵⁶ fixation of the pulmonary artery or aorta to the sternum,⁵⁷ division of the aorta with bypass,⁵ five vertebral osteotomy,¹² and endobronchial stents⁸ have not been consistently successful and do carry a high mortality rate. In the series by Grillo et al.,¹ four patients required complex resections including aortic bypass with three patients also undergoing tracheobronchial resections as a result of malacia. Only one patient had a favorable result. Tracheobronchomalacia is usually an indicator of a poor outcome.

Operations for the purpose of repositioning the mediastinum have included phrenectomy,¹ pericardiorrhaphy,¹ insertion of a prosthesis into the pneumonectomy space (Lucite balls,⁷ Silastic implants,¹,²,¹⁰,¹¹ expandable saline solution prosthesis²,⁸,¹²,¹³), and injection of sulfur hexafluoride¹⁴ into the pneumonectomy space. Phrenectomy performed chemically or surgically has not been successful in the management of PPS. Pericardiorrhaphy performed alone has also not been successful. Methods utilizing prostheses have shown success in the treatment of PPS. The best results have

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**Table 1—Effect of Correction of PPS on Pulmonary Function and Bronchial Diameter**

<table>
<thead>
<tr>
<th>Patient</th>
<th>PEFR</th>
<th>FEV₁/FVC</th>
<th>Bronchial Diameter*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>49</td>
<td>20</td>
<td>300</td>
</tr>
<tr>
<td>2</td>
<td>44</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>43</td>
<td>22</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>40</td>
<td>-2</td>
<td>167</td>
</tr>
<tr>
<td>5</td>
<td>45</td>
<td>24</td>
<td>100</td>
</tr>
<tr>
<td>Mean</td>
<td>44.2</td>
<td>13.2</td>
<td>133.4</td>
</tr>
</tbody>
</table>

*Bronchial diameter was calculated from CT scan.
been obtained by combining anterior pericardiorrhaphy with insertion of an expandable prosthesis into the pneumonectomy space.1,2,10 Our patients were treated by this method and all have benefited enormously.

Our experience includes five patients suffering from PPS who were treated surgically by combining pericardiorrhaphy and insertion of an expandable prosthesis. There has been both subjective and objective improvement in their lung function. All five patients in this series had a left-sided aortic arch. They have all had an improvement in their dyspnea. None of our patients have had malacia of the airway and therefore have not required bronchial resection, aortic bypass, or endobronchial stents.

CONCLUSION

PPS is a rare cause of dyspnea, stridor, and recurring pneumonia after lung resection. With a high index of suspicion, it can be diagnosed accurately using bronchoscopy, radiography, and PFTs. Repositioning of the mediastinum with a saline solution-filled prosthesis and anterior pericardiorrhaphy is easily performed and provides and immediate and lasting symptomatic relief. The early diagnosis and treatment of PPS should prevent tracheobronchomalacia, which can be much more difficult to treat.

REFERENCES

1 Grillo HC, Shepard JO, Mathisen DJ, et al. Postpneumonec-
2 Shamji FM, Deslauriers J, Daniel TM, et al. Postpneumonec-
3 Powell RW, Luck SR, Raffensperger JG, et al. Pneumonec-
4 Boiselle PM, Shepard J, McLoud TC, et al. Postpneumonec-
5 Harrison MR, Hendren WH. Agenesia of the lung compli-
6 Quillin SP, Shackelford GD. Postpneumonecctomy syndrome after left lung resection. Radiology 1991; 179:100–102
7 Adams HD, Junod FL, Aberdeen E, et al. Severe airway obstruc-
10 Wasserman K, Jampis RW, Lash H, et al. Postpneumonec-
12 Audry G, Balquet P, Vazquez MP, et al. Expandable pro-
13 Rasch DK, Grover FL, Schnapf BM, et al. Right postpneu-

Herbicide (Roundup) Pneumonitis*

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A case of acute intoxication presented as toxic pneumonitis after exposure to Roundup (glyphosate) (Solaris Group, Monsanto; San Ramon, CA) herbicide in an agriculture worker. The correct etiologic factor causing this specific clinical picture was identified only 2 weeks later, after a thorough occupational history was taken and meticulous delineation of the working conditions and exposures of the involved worker were made. As a rule, occupational related diseases are not readily elucidated by nonoccupational physicians. However, most acute intoxication events are first encountered by such physicians. In these situations, rapid and comprehensive evaluation is necessary in order to clearly identify the causative agent(s) and to initiate the appropriate treatment. Consulting occupational physicians at this early stage may facilitate early and accurate diagnosis.

(CHEST 1998; 114:1769–1771)

Key words: herbicides; occupational history; occupational lung disease

Abbreviations: ED = emergency department; OP = organophosphate

A cute pulmonary symptoms necessitating hospitalization are not rare in agriculture workers. Frequently, there is an a priori assumption by emergency department (ED) and house staff that the causative agent is an organophosphate (OP) pesticide (acetylcholinesterase inhibitor). Many times, no further effort is made to identify the exact nature of the involved noxious material. This is unfortunate because there are many (newer) pesticides and herbicides in use, whose actions are based on different mechanisms. Understanding their toxicologic effects in humans could facilitate proper treatment, if an intoxication should occur.

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Manuscript received February 24, 1998; revision accepted June 1, 1998.

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