Hernia of the Lung
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Background. Lung hernia is uncommon and methods of management vary. During the past 17 years, we have seen 8 patients with this condition.

Methods. Between 1984 and 2000, 8 patients with lung hernias were seen on our service. Three hernias were caused by a thoracic operation, one was due to chronic cough, and in four, the hernia was congenital, with delayed presentation.

Results. Three patients had minimal symptoms and were not operated on. Closure of chest wall in the other patients was accomplished by suture approximation of ribs in 4 patients and by polypropylene mesh in 1 patient. There were no recurrences, and these patients remain asymptomatic.

Conclusions. Intercostal hernias are usually symptomatic and should be treated by operative closure. In supraclavicular hernias, the symptoms are usually minimal and complications are unlikely. These hernias can be left untreated, but the patients should be followed.

Lung hernia is an uncommon condition. According to Goverde and associates [1] and to Ross and Burnett [2], only about 300 patients have been reported, most of them as single case reports. Our experience with this entity totals 8 patients seen during the past 17 years.

Patients and Methods
During the years 1984 to 2000, 8 patients with lung hernia were seen at the Wolfson Medical Center (Table 1). There were three male and five female patients, ranging in age from 25 to 73 years. All patients were symptomatic. Four complained of pain. Bulge was present in seven instances; in 3 patients it was present most of the time regardless of straining, whereas in 4 patients, it was elicited by straining only. In 1 patient, the bulge was not present, but the chest defect was palpated. The diagnosis was confirmed by chest radiography in 3 patients and by computed tomographic scan in 4 patients. Three patients had a preceding thoracic operation: resection of desmoid tumor of the chest wall (patient 5), open lung biopsy (patient 6), and pleuroscopy with pleural drainage (patient 3); in 1 patient with chronic obstructive pulmonary disease, the apparent cause of hernia was chronic cough (patient 8); whereas in 4 patients (two supraclavicular [patients 1 and 4], and two intercostal [patients 2 and 7]), there was no history of previous operation or trauma; these hernias were congenital, with delayed presentation.

Approximation of ribs was performed in 4 patients (2, 3, 6, and 7). This was done using No. 1 monofilament nylon sutures placed pericostally in the figure-of-eight fashion. In 1 patient (5), the gap was closed with polypropylene (Marlex [Davol, Cranston, RI]) mesh. In a muscle-sparing thoracotomy, an 8-cm by 12-cm patch of mesh was placed deep into the bony thorax and sutured to the internal thoracic fascia, overlapping the edges of the gap by 1.5 cm on all sides. The area of repair was then covered with the latissimus dorsi muscle. In 3 patients with supraclavicular hernia (two congenital, one chronic obstructive pulmonary disease), no operative repair was attempted (Table 2).

Results
All patients remain under follow-up (Table 2). Three patients who were not operated on (1, 4, and 8) remain under observation. There was no progress of their disease and their symptoms remain minimal. Four patients with intercostal hernia (2, 3, 6, and 7) treated by placing intercostal sutures, are well, with follow-up ranging from 2 to 16 years. The patient treated with Marlex mesh closure (patient 5) is well 1 year, 5 months after the operation. There were no complications related to the operative procedures.

Comment
Lung hernia is a rare condition. It was first described by Roland (cited in [3]). Since then approximately 300 patients have been reported [1, 2]. In the majority of reported patients, the lung herniated through the intercostal space as a result of trauma or after thoracic operation; most of the other hernias were congenital. The most widely accepted classification of lung hernia is that of Morel-Lavallee [4], based on both the etiology and anatomic location. Classification by etiology recognizes two groups: congenital or acquired, the latter further divided into traumatic, spontaneous, and pathologic. Anatomically, hernias are classified into cervical and...
Table 1. Patient Characteristics

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Sex/Age</th>
<th>Anatomy and Size of Defect</th>
<th>Etiology</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Male/25</td>
<td>Supraclavicular, left, 5 cm diameter*</td>
<td>Congenital</td>
<td>Bulge upon straining and coughing, 1 year</td>
</tr>
<tr>
<td>2</td>
<td>Male/62</td>
<td>Absence of intercostal muscles and fascia between ribs 7–8, right anterolateral, and discontinuous costal arch; also, diastasis of abdominal recti muscles, 1.5 × 5 cm</td>
<td>Congenital</td>
<td>Pain, bulge upon straining, many years</td>
</tr>
<tr>
<td>3</td>
<td>Male/68</td>
<td>Left posterolateral, between ribs 6–7, 1.5 × 3 cm</td>
<td>Pleuroscopy for empyema, pleural drain; after removal of drain, the lung herniated.</td>
<td>Local bulge, 4 months</td>
</tr>
<tr>
<td>4</td>
<td>Female/32</td>
<td>Supraclavicular, right, 4 cm diameter*</td>
<td>Congenital</td>
<td>Bulge upon straining, several years</td>
</tr>
<tr>
<td>5</td>
<td>Female/73</td>
<td>Missing ribs 7, 8, left lateral, 5 × 9 cm</td>
<td>Resection of desmoid tumor of chest wall (ribs 7, 8); original repair by approximation of soft tissues failed</td>
<td>Pain and bulge, 4 years</td>
</tr>
<tr>
<td>6</td>
<td>Female/63</td>
<td>Gap between ribs 5–6, left, due to inadequate closure at minithoracotomy for lung biopsy, 2 × 5 cm</td>
<td>Preceding operation, inadequate closure</td>
<td>Pain, occasional bulge, 1 month</td>
</tr>
<tr>
<td>7</td>
<td>Female/39</td>
<td>Left submammary; absent intercostal muscles and fascia between ribs 5–6, 2 × 4 cm</td>
<td>Congenital</td>
<td>Pain, 6 months</td>
</tr>
<tr>
<td>8</td>
<td>Female/42</td>
<td>Supraclavicular, left, 3.5 cm diameter*</td>
<td>COPD, chronic cough</td>
<td>Bulge upon straining and coughing, at least 2 years</td>
</tr>
</tbody>
</table>

* The measurements of supraclavicular hernias are approximate.

COPD = chronic obstructive pulmonary disease.

Thoracic. Congenital hernias result from attenuation of the endothoracic fascia. They occur either at the thoracic inlet or at the intercostal spaces, where weakness of the fascia is usually combined with absence of the intercostal muscles. The majority of acquired hernias result from trauma to the chest (penetrating or blunt), or from preceding operative procedure with inadequate closure of the chest wall. It is of interest that postoperative intercostal hernias are reported more commonly after less extensive surgical procedures, such as video thoracoscopy [5, 6], than after major thoracic interventions. It may be due to a less meticulous closure of the “mini” incisions as opposed to routine thoracotomy closure. Pathologic hernias are the least common variety and have been reported as sequelae of abscess in the chest wall or breast, empyema necessitatis, malignant tumors, and tuberculous osteitis [7]. Some congenital hernias present later in life. Some

Table 2. Treatment and Results

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Sex/Age</th>
<th>Indications for Operation</th>
<th>Treatment</th>
<th>Results at Last Follow-Up (2001)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Male/25</td>
<td>None</td>
<td>None</td>
<td>No change, 17 years</td>
</tr>
<tr>
<td>2</td>
<td>Male/62</td>
<td>Pain</td>
<td>Pericostal heavy nylon sutures; approximation and suture of abdominal recti muscle</td>
<td>Well, 16 years</td>
</tr>
<tr>
<td>3</td>
<td>Male/68</td>
<td>Cosmetic</td>
<td>Pericostal heavy nylon sutures</td>
<td>Well, 6 years 2 months</td>
</tr>
<tr>
<td>4</td>
<td>Female/32</td>
<td>None</td>
<td>None</td>
<td>No change, 6 years</td>
</tr>
<tr>
<td>5</td>
<td>Female/73</td>
<td>Pain, cosmetic</td>
<td>Marlex mesh closure, covered with muscles</td>
<td>Well, 1 year 5 months</td>
</tr>
<tr>
<td>6</td>
<td>Female/63</td>
<td>Pain</td>
<td>Pericostal sutures</td>
<td>Well, 5 years</td>
</tr>
<tr>
<td>7</td>
<td>Female/39</td>
<td>Pain, cosmetic</td>
<td>Pericostal heavy nylon sutures</td>
<td>Well, 2 years</td>
</tr>
<tr>
<td>8</td>
<td>Female/42</td>
<td>None</td>
<td>None</td>
<td>No change; under close observation 2 years</td>
</tr>
</tbody>
</table>
patients simply may not have noticed an asymptomatic hernia that has been present for a long time. In other patients, this could be due to progressive muscle weakness. However, as no data are available, this is a matter of speculation.

Uncomplicated lung hernia can be asymptomatic. However, the common presentation is a soft, tender, subcutaneous mass that enlarges on physical strain or coughing (Fig 1). In absence of a palpable mass, Valsalva maneuver will usually cause the bulge to appear. Traumatic hernias may appear immediately after injury or be delayed for years [8]. The patient may report on a recent or remote trauma to the chest wall. A soft mass at the site of trauma may become apparent immediately after trauma or years later. Diagnosis should be confirmed by a chest radiography or a computed tomographic scan (Fig 2). Lateral and oblique radiographs may disclose lung parenchyma outside the bony cage, and rarely, a larger than normal intercostal space. A computed tomographic scan is necessary to assess the exact location and size of the defect [9]. Spiral computed tomographic scan with the patient performing the Valsalva maneuver may provide the most accurate imaging method [5].

Both surgical and conservative management have been recommended. Asymptomatic hernias, particularly those in the supraclavicular location, require no treatment. Increasing size, pain, and any signs of impending incarceration, such as difficulty to reduce the hernia, are the main indications for operation. A small defect increases the risk of incarceration and makes reduction more difficult. Therefore, in patients with small defects, operation should not be delayed. Repair for cosmetic reasons is sometimes justified. Our 3 patients with supraclavicular hernias and minimal symptoms remained under observation without treatment, and no change has occurred.

For closure of the defect, Munnell [7] recommended the use of autologous tissues, whenever possible. Synthetic materials, such as Dacron, Ivalon, Teflon, or Marlex were considered acceptable, when local tissues were not available or of poor quality. The synthetic material serves as a framework on which a firm layer of connective tissue grows, resulting in satisfactory reconstruction of the chest wall. We have used a patch of Marlex mesh covered with muscles in 1 patient. The patient remains well at 17 months. May and associates [10] reported on a traumatic anterior lung herniation secondary to shoulder seat-belt restraint injury. The defect was closed with size 4 wires, and the muscles were approximated. According to Goverde and colleagues [1], pericostal fixation of the adjacent ribs suffices for bridging the defect. This technique was used in 4 of our patients with intercostal hernia, with excellent results and no recurrences. For larger defects, they recommended repair by plastic procedures, using periosteum and muscles or fascia lata. Synthetic materials, such as Marlex mesh or polytetrafluoroethylene patch, were considered acceptable as an alternative.
Brock and Heitmiller [11] reviewed 14 case reports of “spontaneous” lung hernia—all due to cough, sneeze, or abnormal motion, but without history of chest trauma, and added 2 patients of their own, for a total of 16 patients. Although primary surgical repair of anterior lung hernias without prosthetic material was successfully accomplished in 7 of the 16 patients (44%), they preferred to use the prosthetic patch to close the defect, restore costal continuity, and reattach the abdominal fascia. Jacka and Luison [12] combined two methods of repair for this type of lesion: primary closure of the defect by pericostal wire sutures and intrathoracic placement of prosthetic material (polytetrafluoroethylene) to maintain reduction of the lung. Another method of two-layer repair was described by Ross and Burnett [2]. A patch of expanded ploytetrafluorosphene was used as an intrathoracic parietal pleural layer and was buttressed by an externally applied intercostal chest wall patch of polypropylene mesh. Deeik and associates [13] used a composite of Marlex mesh and methyl methacrylate sutured to the edges of the skeletal defect. Marlex mesh (Davol, Cranston, RI), Vicryl mesh (Ethicon, Sommerville, NJ), Prolene mesh (Ethicon, Sommerville, NJ), and expanded polytetrafluoroethylene patch (Goretex [Gore and Associates, Flagstaff, AZ]) all have their advocates [14]. Soft tissue coverage, such as skin grafts, muscle flaps, or omentum, is necessary only if there is a loss of soft tissue [13]. An innovative approach was suggested by Reardon and colleagues [15] who applied video thoracoscopy for repair of a traumatic intercostal pulmonary hernia. After release of the adhesions, the herniated lung was reduced with a bimanual push–pull technique. While the assistant applied gentle pressure over the bulging area, traction was applied to the herniated lung with a large atrumatic grasper under the videoscopic control. To prevent recurrence, they closed the intercostal defect with approximating sutures.

No one method is applicable to every lung hernia, and the management of our patients was individualized. Three of our patients, all with supraclavicular hernia (two congenital, one chronic obstructive pulmonary disease) were not treated operatively. Their symptoms were minimal, and no change occurred during the period of observation that ranged from 2 to 17 years. In 4 patients with intercostal hernia (two congenital, two postoperative), pericostal heavy nylon sutures were used, and in addition, in 1 patient, the abdominal recti muscles were suture-approximated. In 1 patient with a large hernia after resection of a chest wall tumor, the defect was closed with Marlex mesh and covered with serratus and latissimus dorsi muscles.

Intercostal lung hernias are uncommon. They usually follow external chest trauma, operation, or violent cough. Because of symptoms and possible complications, operative intervention is usually necessary. Small intercostal hernias should not be exempt. In contrast, the size of the defect in supraclavicular hernias is usually large, with complications unlikely. Most of these hernias can be left untreated.

References