Case reports

Surgical Endoscopy

Surg Endosc (1995) 9: 1204–1206
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Thoracoscopic plication of the diaphragm

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Received: 15 February 1995/Accepted: 22 May 1995

Abstract. Plication of the diaphragm in symptomatic patients with phrenic nerve paralysis provides excellent relief of exertional dyspnea and significantly increases arterial oxygen tension, and all lung volumes except residual volume. We report diaphragmatic plication using the minimally invasive technique of VATS. This procedure provides excellent relief of symptoms with minimal morbidity and short hospitalization.

Key words: Phrenic nerve paralysis — Exertional dyspnea — VATS

Recent advances in video technology and instrumentation have resulted in the application of thoracoscopy to many anomalies of the chest [3, 5, 6]. Video-assisted thoracic surgery (VATS) results in marked reduction of postoperative pain, need for intensive medical care, hospital stay, and the overall recovery period [4]. VATS an ideal approach to patients suffering from malignant diaphragmatic paralysis, a condition which presents a significant risk with conventional thoracotomy. Here, we report a case of malignant phrenic nerve involvement associated with unilateral diaphragmatic paralysis which was plicated using video-assisted thoracic surgery.

Report of case

A 72-year-old white female presented to the Mayo Clinic Scottsdale with left neck and shoulder pain and subacute onset of dyspnea on exertion. The pain was constant, was not modified by activity, and was minimally relieved by oral analgesics. She reported becoming increasingly short of breath during the 3 months prior to presentation. The patient reported a 30-pack-year history of smoking.

Postero-anterior and lateral chest radiographs revealed elevation of the left hemidiaphragm and a mass overlying the aortic arch (Fig. 1). Contrast-enhanced computerized tomography showed an anterior mediastinal mass projecting into the left hemithorax and overlying the aortic arch (Fig. 2). The mass appeared to be encasing the left phrenic nerve; mediastinal nodes were not enlarged. The left lower lobe was compressed by an elevated left hemidiaphragm. Thoracoscopic examination confirmed the paralysis of the left hemidiaphragm. Preoperatively, the diagnosis of lymphatic vs thymic malignancy was entertained.

The patient underwent video-assisted thoracic surgery. After induction of anesthesia, the patient was intubated with a double lumen endotracheal tube. Two small incisions were made in the anterior and posterior axillary lines in the seventh intercostal space. A third incision was placed in the paravertebral region of the fifth intercostal space. A rigid 10.0-cm thoracoscope (Karl Stortz, Culver City, CA) was inserted through the fifth interspace incision. Inspection of the pleural space revealed multiple granulomata throughout the lung. The anteromedial aspect of the right upper lobe was adherent to a mass measuring 2 × 3 cm which covered the aortic arch and the AP window and encased the left phrenic nerve. Biopsy of the mass revealed a thymic carcinoma. In order to disrupt the sensory neural pathways from the phrenic nerve, a segment of the nerve proximal to the tumor mass was excised. The diaphragm was plicated in order to facilitate the full expansion of the left lower lobe. The thoracoscope was moved to the incision in the posterior aspect of the seventh interspace. Two long conventional needle drivers were used and placed through the anterior seventh interspace and the fifth interspace incisions (Fig. 3). Five rows of number 1 Ethibond suture (Ethicon, Inc.) were used to plicate the diaphragm in an anteromedial-to-posterolateral direction. Care was exercised in placing the sutures as to prevent injury to the intraabdominal structures. The paralyzed hemidiaphragm was lifted up and sutures were placed in the elevated portion. Each row of sutures consisted of seven to eight pleats. The sutures were tied resulting in progressive shortening of the diaphragmatic leaf (Fig. 4). The postoperative chest radiograph revealed complete expansion of the left lower lobe and a flattened left hemidiaphragm. The patient did not require ventilatory support and noted significant improvement in dyspnea. Furthermore, the patient reported complete resolution of the left shoulder pain. Patient was discharged from the hospital on the 2nd postoperative day. Mediastinal radiation therapy was started immediately following discharge from the hospital.

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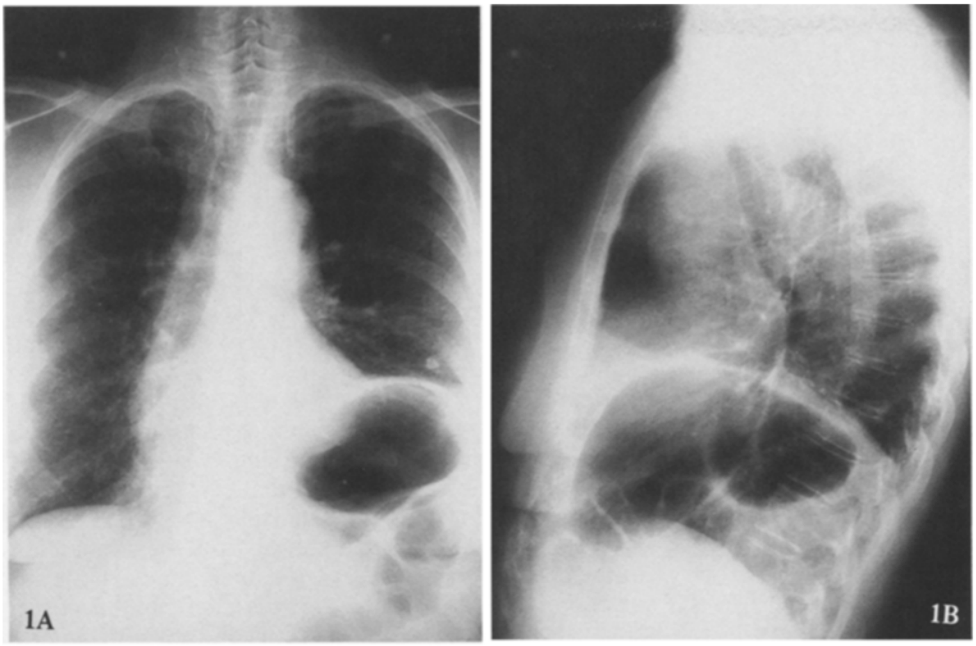

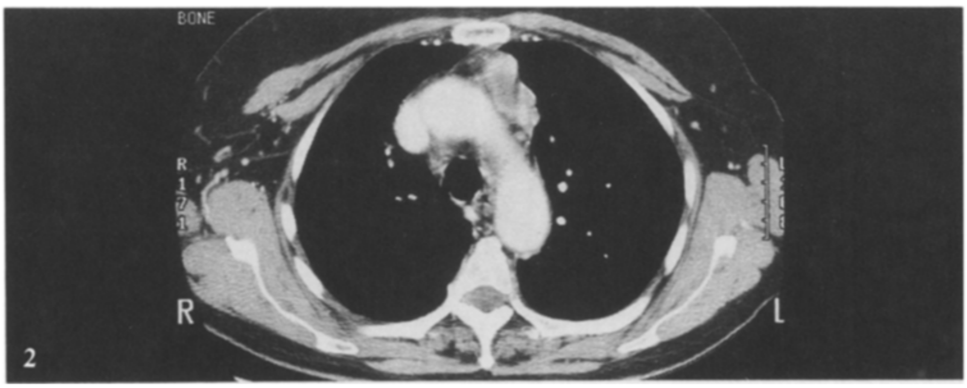

Fig. 1. Postero-anterior **(A)** and lateral **(B)** chest radiographs revealing an elevated left hemidiaphragm. The postero-anterior radiograph shows a mass overlying the aortic arch.

Fig. 2. Contrast-enhanced computerized tomogram of the aortic arch. There is a mass overlying the aorta. This mass involves the phrenic nerve as it courses over the aortic arch.

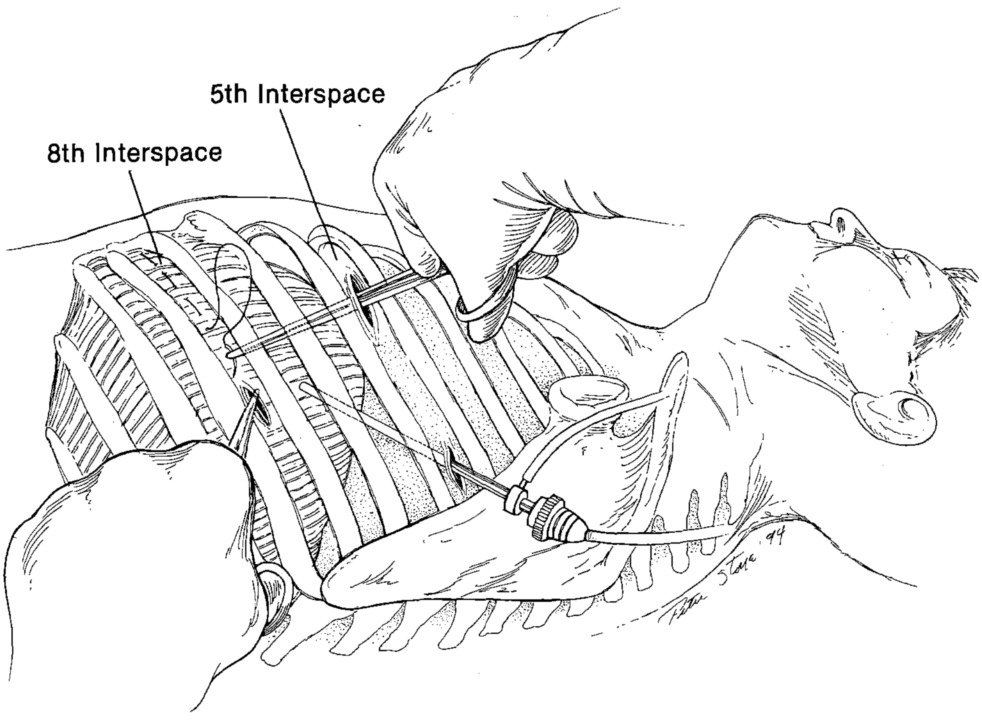

Fig. 3. Technique of VATS diaphragmatic plication. Conventional needle drives are used through the fifth intercostal space anteriorly and the eighth intercostal space posteriorly. The diaphragm is plicated from an anteromedial to posterolateral direction.

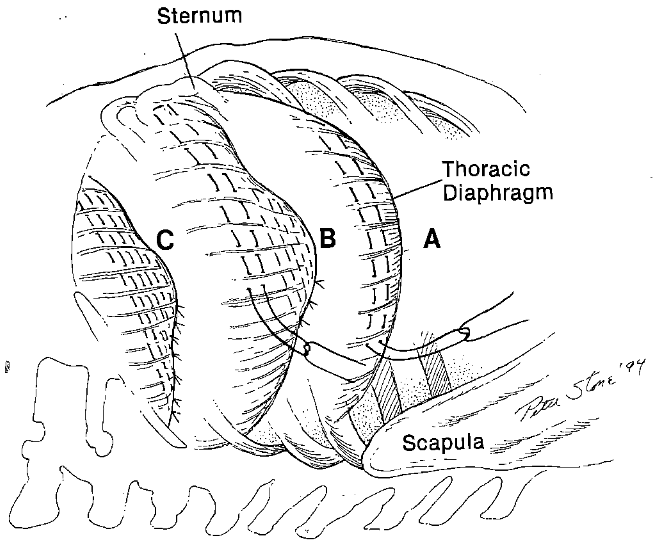

Fig. 4. Close-up view of the left hemidiaphragm. Five rows of nonabsorbable sutures are placed. Each suture consists of seven to eight pleats (**A**). The sutures are tied resulting in the progressive flattening of the nonfunctioning diaphragmatic leaf.

Discussion

The diaphragm plays a significant role in ventilation. During quiet breathing it moves 75–80% of the total air into the lung [1]. This role is greatly increased with deep, forced ventilation. Although a paralyzed hemidiaphragm can be tolerated by a normal individual, the resultant 20–30% reduction in vital capacity and total lung capacity can be significant in the presence of pulmonary disease [2]. Furthermore, the paradoxic movement of the paralyzed hemidiaphragm interferes with an effective cough. Diaphragmatic paralysis usually results from the involvement of the phrenic nerve from its central nuclei to the peripheral nerve trunk with tumor, infection, or trauma. Unexplained diaphragmatic paralysis is associated with a malignancy only in 3.5% of patients and improves in less than 10% of the individuals [7]. In symptomatic patients, transthoracic diaphragmatic plication provides excellent relief of exertional dyspnea and significantly increases arterial oxygen tension and all lung volumes except residual volume [7].

Video-assisted thoracic surgery has resulted in significant changes in the treatment of thoracic anomalies. VATS obviates the need for a large intercostal incision and consequently results in not only greater patient comfort but significantly decreased postoperative morbidity [4]. These characteristics make VATS especially useful in patients with ventilatory compromise.

Our patient presented with a mass overlying the aortic arch. The mass invaded the phrenic nerve and resulted in progressive dyspnea on exertion from unilateral diaphragmatic paralysis. The conventional approach to biopsy of the mass and an attempt at plication of the diaphragm would have required a formal thoracotomy. VATS offered the possibility of making a diagnosis and performing the diaphragmatic plication to three small incisions. As illustrated in our patient, the postoperative recovery is quite uncomplicated and there is no requirement for ventilatory support. This is due to the combination of minimal compromise in pulmonary function from the incision and a significant increase in lung volumes resulting from the application of the diaphragm. Furthermore, since the incisions are placed on the lateral aspect of the chest, anteroposteriorly directed postoperative radiotherapy can be started immediately after surgery.

Video-assisted thoracic surgical diaphragmatic plication should be considered in patients who are symptomatic from diaphragmatic paralysis. This procedure should provide excellent relief of symptoms with minimal attendant morbidity.

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