Total thoracoscopic pneumonectomy: Indications and technical considerations

A. Alan Conlan, MD, FRCS(C), and Andras Sandor, MD, Worcester, Mass

Dr Conlan

Dr Sandor

Although descriptions of series of thoracoscopic wedge resections and lobectomies have been published, with increasing frequency and encouraging results,¹⁻⁴ only a handful of individual reports of minimally invasive pneumonectomy are available.⁵⁻⁹ The authors of these publications unanimously have used a limited 6- to 16-cm thoracotomy to allow the introduction of traditional surgical instruments and to provide some direct visualization of the surgical field, especially the hilar structures. This has been traditionally accepted as the method of choice in video-assisted thoracic surgery (VATS). However, it is arguable, that the requirement for a minithoracotomy, particularly if rib spreading or rib resection is used, reduces the benefits of minimal trauma associated with the smaller incisions.^{10,11} VATS wedge resections and anatomic lobectomies are frequently performed. The indications, preoperative patient workup, postoperative care, and basic oncologic principles are essentially the same as with open thoracic surgery. We use preoperative mediastinoscopy before any lung cancer resection. We discuss here our initial experience with entirely videothoracoscopic pneumonectomy, such as has not been reported to date.

Clinical Summary

A 75-year-old man underwent workup by his pulmonologist for fatigue, chronic cough with postnasal drip, and recurrent left upper lobe pneumonia, as evidenced by chest radiograph. The patient had a long history of smoking but had quit 25 years previously. Computed tomographic scan of the chest revealed a 3 × 3-cm

inhomogeneous left hilar mass, producing postobstructive pneumonia and atelectasis without evidence of enlarged paratracheal or subcarinal lymph nodes (Figure 1).

On bronchoscopy, an obstructing tumor was visualized in the left upper lobe; this tumor extended to involve the lower lobe origin and the distal left main bronchus. Mediastinoscopy with sampling of levels II and IV bilaterally and level VII revealed reactive lymph nodes without evidence of metastases. Through a modified left anterior mediastinotomy (hideoscopy) levels V and VI were also sampled, and no metastatic deposits were found. Left pneumonectomy was planned. Sleeve resection was excluded by the endobronchial extent of the carcinoma. Medical clearance (preoperative forced expiratory volume in 1 second of 2.24 L) and informed consent were obtained.

Details of the procedure. After induction of anesthesia, a double-lumen endotracheal tube was placed, and the patient was placed in full left lateral position. The distal half of the operating table was lowered, and the chest was elevated with an axillary towel roll to move the iliac crest away from the scapula and to widen the intercostal spaces. Three thoracoscopy ports were made, each about 2 cm in diameter. The first incision was made in the seventh intercostal space in the midaxillary line for the video camera. The 30° videothoracoscope was connected to a 3-chip digital camera system (Smith & Nephew Endoscopy, Andover, Mass) and two monitors were used. After inspection of the chest cavity, the additional trocar positions were determined. Incisions were in the fifth intercostal space for the operating trocars, one in the midclavicular line and one in the posterior axillary line.

The left upper lobe was largely atelectatic, consolidated, and indurated. Inflammatory adhesions were visible between the lung and the aortopulmonary window, and reactive adenopathy was evident in this region. The adhesions were taken down with electrocautery. The inferior pulmonary ligament was then divided, and inferior pulmonary vein was dissected free and transected with a vascular stapler (Endo GIA Universal 2.5 mm; U.S. Surgical, Norwalk, Conn).

Similarly, the lingular and the superior pulmonary veins were dissected free, encircled, and transected with a vascular stapler. The main bronchus was then cleared of adjacent lymphatic and fatty tissue, and the bronchial arteries were secured with clips and divided. The main bronchus was then encircled with a red rubber catheter and divided using a thick tissue stapler (Endo GIA Uni-

From the Division of Thoracic Surgery, Department of Surgery, University of Massachusetts Medical School and UMass Memorial Healthcare, Worcester, Mass.

Received for publication Jan 10, 2003; accepted for publication May 28, 2003.

Address for reprints: A. Alan Conlan, MD, FRCS, Professor of Surgery, Division of Thoracic Surgery, Department of Surgery, University of Massachusetts Medical School/UMass Memorial Healthcare, 55 Lake Ave N, Worcester, MA 01655 (E-mail: ConlanA@ummhc.org).

J Thorac Cardiovasc Surg 2003;126:2083-5

Copyright © 2003 by The American Association for Thoracic Surgery

0022-5223/2003 \$30.00 + 0

doi:10.1016/S0022-5223(03)01227-3

Figure 1. Left upper lobe atelectasis and opacification of distal left main bronchus caused by carcinoma.

versal 4.8 mm; U.S. Surgical). The bronchial stump was then oversewn with 2-0 Prolene suture (Ethicon, Somerville, NJ) with intracorporeal suturing technique, and a knot pusher was used to secure the knots.

Finally, the main pulmonary artery was dissected free from adhesions with electrocautery and fine sponge dissection and then divided at its major proximal divisions with vascular staples. The remaining adhesions were divided, and the pneumonectomy specimen was placed in a retrieving bag (Endo-Catch II; U.S. Surgical). The anterior trocar incision was dilated to accept three fingers, and the specimen was removed without any incident.

Frozen-section analysis of the specimen revealed that the resection line was within a few millimeters of the microscopic spread of the tumor. We therefore continued the dissection of the main bronchial stump up under the aortic arch, to give further length. A thick tissue stapler was reapplied, and a further 2 cm of the left main bronchus was removed. The bronchial stump was oversewn again with 2-0 Prolene suture in an interrupted fashion, and finally pleura was used to cover the stump.

The left pleural cavity was then copiously irrigated with saline solution. The bronchial stump had negative results of testing for air leak. A 28F chest tube was kept under suction during port closure, and it was removed at the end after centralization of the mediastinum. The operative time was 3 hours, and the intraoperative blood loss was 200 mL. The patient tolerated the procedure well and was extubated at the end of the procedure.

Postoperative care. The patient ambulated on the night of surgery and required minimal oral pain medication. A small volume of stable subcutaneous emphysema was noted on the chest radiograph on postoperative day 1. In addition, atrial fibrillation

developed and was treated on postoperative day 3 to 4; it resolved with medical management within 2 weeks.

The pathology report noted a left hilar $4.0 \times 2.5 \times 1.8$ -cm moderately differentiated invasive squamous cell carcinoma. The 2-cm bronchial margin was negative. Visceral pleural invasion and intrapulmonary metastases were absent. Three of 16 N1 (intrapulmonary) lymph nodes were positive for metastatic carcinoma. All N2 lymph nodes were negative. The final stage was stage IIB (pT2 N1 Mx).

Discussion

The acceptance of VATS among thoracic surgeons has been cautious, as reflected by the relative paucity of reports on the subject. This is due to initial discouragement with technical difficulties, prolonged operative times, lack of training in minimal access and videoscopic surgery, and inconclusive randomized prospective clinical trials supporting better outcomes.

Thoracoscopic curative resection of non-small cell primary lung cancer is feasible if the lesion is peripheral in location and 3 cm or smaller in diameter. We use the thoracoscopic approach for pulmonary lobectomy for stage I and II tumors after thorough mediastinoscopy.

Thoracoscopic pneumonectomy should be reserved for centrally located tumors, small tumors involving central structures, and synchronous tumors in the same lung. The essential criteria for entirely thoracoscopic pneumonectomy are listed in Table 1. Thoracoscopic pneumonectomy is currently performed by only a few groups in the world.^{5-7,12} These procedures are performed with the VATS technique through an accessory thoracotomy.

TABLE 1. Essential criteria for entirely thoracoscopic pneumonectomy

- Small tumor mass
- Central tumor location
- Synchronous tumors on same side of the lung
- Negative mediastinoscopy and thoracoscopy
- Operator experience
- Nonemphysematous lung
- Tolerance to double-lumen intubation
- No evidence of pleural symphysis

Thoracoscopic surgery without accessory thoracotomy and rib spreading is desirable. The key to effective and successful maneuvering within the thoracic cavity is optimal port placement and the use of a 30° videothoracoscope. Through 1- to 2-cm ports, standard thoracoscopic instruments (graspers, scissors, hook cautery), and a common ring clamp are used for lung retraction and manipulation.

Dissection of the vascular structures requires thorough knowledge and ample experience in open surgery. The pulmonary artery is best taken at its proximal larger divisions. The dissected portion of vascular structures is encircled by a red rubber catheter, which facilitates positioning of the vessel to accept the jaws of the stapling device. An appropriately sized sponge stick clamp should always be available for rapid insertion and pressure tamponade in case rapid conversion to thoracotomy is indicated.

A thick tissue stapler is required to safely close the main bronchus, and the stapled stump is oversewn with Prolene suture with an intracorporeal suturing technique. The utility of the endo-thoracic bronchial closure is demonstrated by the need to repeat it. Our initial judgment of bronchial stump length was incorrect. An additional 2-cm segment of the left main bronchus required removal to achieve a generous clear margin.

The resected lung should be retrieved with an appropriate size reinforced specimen bag. The pneumonectomy specimen handling is described in Table 2. The neck of the bag is brought through the incision, which is gently dilated by placing three fingers through the port site. If the entire specimen is extracted in one piece, the final incision size will be determined by the actual tumor size. The diameter and volume of the specimen can be reduced further by endobronchial suction atelectasis. Alternatively, after the neck of the bag is extracted the specimen may be removed in large pieces and submitted for histologic assessment.¹³ A pneumonectomy specimen (especially left) can be removed as two attached lobes when grasped by the upper lobe when the central tumor is small. The external bag neck must be opened to release the air collection, which otherwise exerts an additional volume effect. The lobes are delivered sequentially. Postoperative management is similar to that after open pneumonectomy.

Conclusion. Thoracoscopic pneumonectomy without accessory thoracotomy access is technically challenging for

TABLE 2. Pneumonectomy specimen handling

- Prolonged atelectasis to reduce volume
- Suction augmentation of atelectasis
- Strong lubricated bag
- Marsupialization of bag and release of air
- Reduction of specimen in bag to allow extraction
- Sequential lobectomy slide technique

the thoracic surgeon. The minimally invasive approach requires additional judgments and expertise. Safe surgical dissection must be maintained, vascular variants must be understood, and the extent of surgery must not be compromised because of the thoracoscopic approach. We believe that the oncologic standards for resecting and staging non-small cell lung cancer can be met with thoracoscopic pulmonary resection and meticulous mediastinoscopy.

References

1. McKenna RJ Jr, Fischel RJ, Wolf R, Wurnig P. Video-assisted thoracic surgery (VATS) lobectomy for bronchogenic carcinoma. *Semin Thorac Cardiovasc Surg.* 1998;10:321-5.
2. Kawahara K, Iwasaki A, Shiraishi T, Okabayashi K, Shirakusa T. Video-assisted thoracoscopic lobectomy for treating lung cancer. *Surg Laparosc Endosc.* 1997;7:219-22.
3. Saito A, Yagi N, Miura K, Takano Y. Video-assisted right lower lobectomy for a lung cancer with mini-thoracotomy. *Surg Laparosc Endosc.* 1995;5:56-8.
4. Liu HP, Chang CH, Lin PJ, Chang JP, Hsieh MJ. Thoracoscopic-assisted lobectomy. Preliminary experience and results. *Chest.* 1995; 107:853-5.
5. Podbielski FJ, Marquez GD, Nelson DG, Dietrich NA, Connolly MM. Thoracoscopic assisted pneumonectomy. *JSLS.* 1997;1:75-7.
6. Yim AP. VATS major pulmonary resection revisited—controversies, techniques, and results. *Ann Thorac Surg.* 2002;74:615-23.
7. Craig SR, Walker WS. Initial experience of video assisted thoracoscopic pneumonectomy. *Thorax.* 1995;50:392-5.
8. Walker WS, Carnochan FM, Mattar S. Video-assisted thoracoscopic pneumonectomy. *Br J Surg.* 1994;81:81-2.
9. Roviato G, Varoli F, Vergani C, Maciocco M. Techniques of pneumonectomy. Video-assisted thoracic surgery pneumonectomy. *Chest Surg Clin N Am.* 1999;9:419-36, xi-xii.
10. Rossi L, Litwin DE, Gowda K. Anatomic thoracoscopic lobectomy (ATL) without minithoracotomy: preliminary experience. *Surg Laparosc Endosc.* 1996;6:49-55.
11. Poulin EC, Labbe R. Fully thoracoscopic pulmonary lobectomy and specimen extraction through rib segment resection. Preliminary report. *Surg Endosc.* 1997;11:354-8.
12. Roviato GC, Rebuffat C, Varoli F, Sonnino D, Vergani C, Maciocco M, et al. Major thoracoscopic operations: pulmonary resection and mediastinal mass excision. *Int Surg.* 1996;81:354-8.
13. Lewis RJ. Simultaneously stapled lobectomy: a safe technique for video-assisted thoracic surgery. *J Thorac Cardiovasc Surg.* 1995;109: 619-25.