doi:10.1510/icvts.2010.244657

INTERACTIVE CARDIOVASCULAR AND THORACIC SURGERY

Interactive CardioVascular and Thoracic Surgery 11 (2010) 721–726

www.icvts.org

New ideas - Thoracic oncologic

The use of video-assisted thoracic surgery in the management of Pancoast tumors☆

Francesco Paolo Caronia[a,*], Enrico Ruffini[b], Attilio Ignazio Lo Monte[c]

[a]*Dipartimento di Chirurgia Toracica, Centro Clinico e Diagnostico Morgagni, 105, Via del Bosco, 94125 Catania, Italy*
[b]*S.C.D.U. Chirurgia Toracica, Università di Torino, 3, Via Genova, 10126 Torino, Italy*
[c]*Dipartimento di Chirurgia 'GENURTO', Università di Palermo, 129, Via del Vespro, 90127 Palermo, Italy*

Received 1 June 2010; received in revised form 29 August 2010; accepted 30 August 2010

Abstract

We describe our experience using video-assisted thoracic surgery (VATS) as an adjunct to the surgical management of Pancoast tumors. Between March 2004 and November 2009, 13 patients with Pancoast tumors were included in this study. Surgery was performed by positioning the patient to allow either an anterior or a posterior thoracotomy. VATS was employed to explore the pleural cavity, to optimize the surgical access and as an assistance during surgical resection. Three patients with pleural carcinosis at thoracoscopy did not undergo further surgery. Seven lobectomies and three wedge resections were performed with an en bloc chest-wall resection and mediastinal lymphadenectomy. The surgical approaches were a transmanubrial L-shaped incision ($n=1$), a posterior thoracotomy ($n=8$), and a combined transmanubrial and posterior thoracotomy ($n=1$) which were dictated by the thoracoscopic findings. The average operative time was 200 min (range: 185–280 min); the average blood loss was 325 ml (range: 250–1200 ml). The average hospitalization was nine days (range: 8–30 days). Our study indicates that VATS may be an effective and safe adjunct to standard surgical resection in patients with Pancoast tumors. It reduces the magnitude of surgery, either by sparing the patient a useless thoracotomy or, by optimizing the site of the thoracotomy. It may also have a significant educational role.

Keywords: General thoracic surgery; Lung cancer; Superior sulcus tumors

1. Introduction

The terminology for Pancoast tumors is based on the first description of a superior sulcus tumor by Henry Pancoast [1], who described it as a carcinoma of uncertain origin that develops in the apex of the chest. According to the definition proposed by Detterbeck, a Pancoast tumor is a lung cancer that is invasive above the level of the second rib [2]. Since the first description of Pancoast tumors in 1932, several surgical approaches have been described for increasingly complex surgical resections. Surgery together with multimodality adjuvant treatments, allows tumors, that were thought to be inoperable until recently, to undergo surgery with improved outcomes. Very few reports have been published about the usefulness of video-assisted thoracic surgery (VATS) in Pancoast tumors treatment. In this study, we present a novel use of VATS as an adjunct to the surgical management of Pancoast tumors.

2. Materials and methods

From March 2004 to November 2009, 18 patients with Pancoast tumor were referred to our center for curative treatment. All patients underwent neoadjuvant chemoradiotherapy. Three patients presented with advanced disease progression during this period and were excluded from the study. Two further patients with histologically proven N2 disease at mediastinoscopy were also excluded. The remaining 13 patients represent the study population. Informed consent was obtained for each patient. Median radiotherapy schedule was 48.3 Gy (range: 45–55 Gy) which was well tolerated in all patients except in one, who developed a radiation-induced dermatitis of the supraclavicular skin.

This was a consecutive cohort of patients from three different tertiary referral centers treated by the same surgical team. In all patients, a preoperative needle biopsy confirmed the diagnosis of non-small cell lung cancer. All patients underwent a standard staging workup. Positron emission tomography (PET) was only included in the preoperative staging in the last seven patients.

The primary outcome measure for the study was the rate of failure of complete resection. The secondary endpoints included the safety of the procedure, with regards to

☆ Presented at the 18th European Conference on General Thoracic Surgery, Valladolid, Spain, May 30–June 2, 2010.

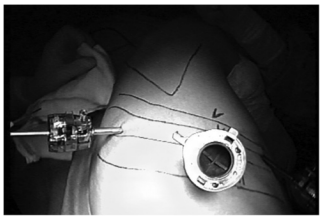
*Corresponding author. Via Principe di Scalea 67/C, 90151 Palermo, Italy. Tel.: +39 335 8426488; fax: +39 091 8431754.
E-mail address: fpcaronia@yahoo.it (F.P. Caronia).

morbidity, mortality, blood loss, and the requirement for blood transfusions. The tertiary outcome measure was the reliability of the procedure from an oncological viewpoint. For this purpose, we studied the rate of true local recurrence after a minimum follow-up of six months.

2.1. Surgical technique

All patients underwent double-lumen endotracheal intubation. The patient was placed in the lateral decubitus position with the arm prepped and protected by drapes so that it could be moved within the operative field. This enabled either an anterior or a posterior thoracotomy (which was established on the basis of the VATS findings) to be performed without the need to change the position of the patient intraoperatively (Fig. 1a,b). The procedure began with the exploration of the pleural cavity using a 30° videothoracoscopic camera. This can be achieved through a 1.5-cm single skin incision with the use of one up to three trocars which enable the thoracoscopic instruments to move the lung, in order to evaluate its relationship with other structures. As an example, Video 1 shows the position of patient number 11 of our series and the location of insertion of the trocars used for thoracoscopic exploration. In each approach, surgery was performed using standard techniques through the thoracotomy with video-assistance. Attention was made to ensure that adequate tumor-free margins were obtained during the rib resection. The radical dissection of all mediastinal lymph nodes was routinely carried out in the standard fashion. Chest drains were placed on suction through the trocar ports. The patient was usually extubated in the operating room and transferred to the postanesthesia care unit.

Fig. 1. Patient position allowing either a posterior (a) or an anterior approach (b) without the need for a change in position.



Video 1. It demonstrates the positioning of the patient to allow an explorative thoracoscopy, a posterior thoracotomy and anterior approach without the need for a change in position during the operation.

2.2. Posterior thoracotomy

Before posterior thoracotomy was performed, a transthoracic needle was used to establish the intercostal space in which the thoracotomy would be performed. Video-assistance allowed a reduction in the size of the thoracotomy, sparing the latissimus dorsi muscle (Fig. 2a), without the need to perform a thoracotomy through the fourth or fifth intercostal space to explore the chest cavity. The incision involved the resection of a rib (Fig. 2b), which enabled exploration of the chest cavity with a digit. A rib spreader was used to elevate the scapula, thus affording an excellent view of the apex of the chest. The resection of the involved chest-wall, attached to the lung, was carried out first to release it into the pleural cavity to allow for either the pulmonary lobectomy or wedge resection. The specimen was then removed en bloc from the pleural cavity.

The posterior defect of the chest-wall was usually covered by the scapula without the need to position a prosthesis (Fig. 2c). Video 2 shows a brief demonstration of the video-assisted posterior approach.

2.3. Transmanubrial L-shaped incision

Vascular control is usually achieved by the posterior approach. Nevertheless, when Pancoast tumors involved the innominate vein or subclavian vessels, or if there were concerns with regards to their control, a transmanubrial L-shaped incision was performed according to the technique described by Grunenwald and Spaggiari [3]. In the single case in our series, the operation was performed through this incision with video-assistance. The specimen could then be removed en bloc from the pleural cavity.

2.4. Combined posterior thoracotomy and transmanubrial L-shaped incision

When Pancoast tumors extended from the anterior to posterior aspect of the thoracic inlet, a combined approach was necessary. In our single case, the first part of operation was performed through a transmanubrial L-shaped incision

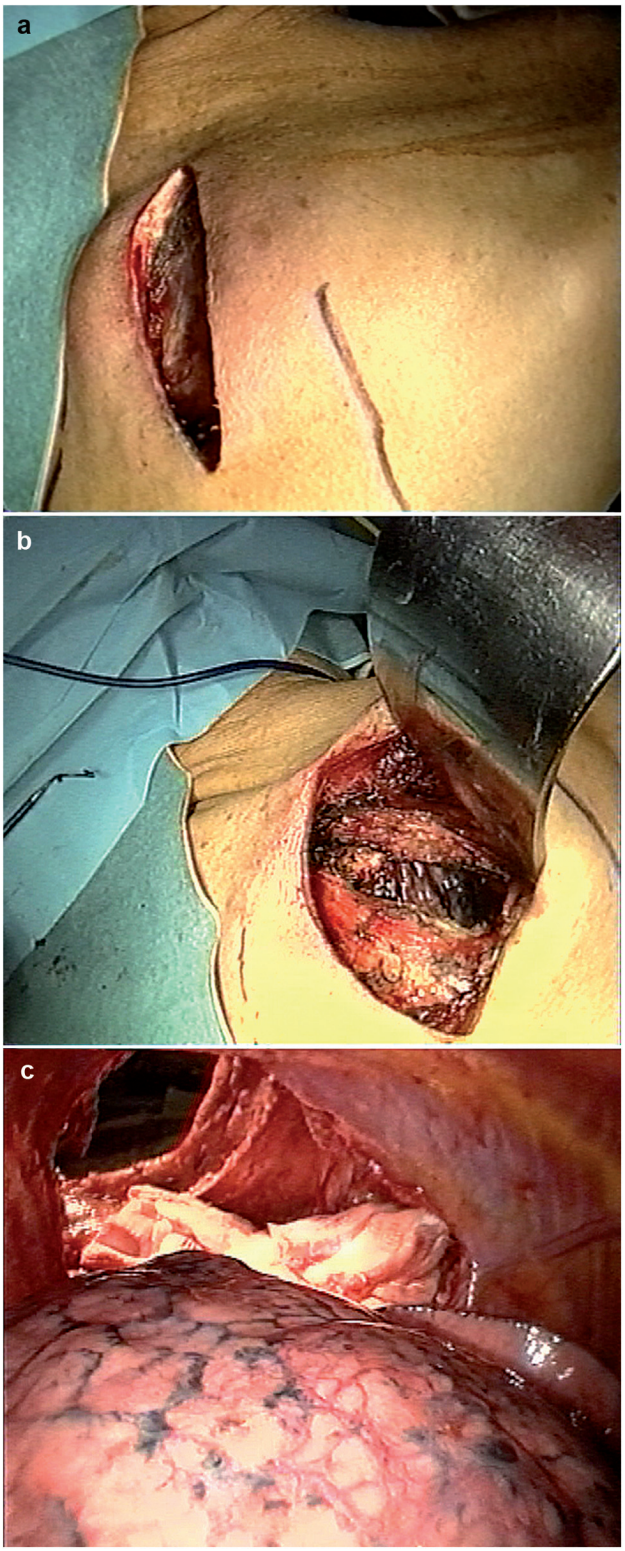


Fig. 2. (a) Right posterior thoracotomy; (b) rib resection which enabled exploration of the chest cavity with a digit; (c) endoscopic view after surgical resection (of the 11th patient of our series).

with video-assistance then the surgeon changed position to perform a video-assisted posterior thoracotomy. The tumor was removed en bloc with all the involved structures

Video 2. A brief demonstration of the video-assisted posterior approach.

through the posterior incision. We closed both wounds after removing the specimen.

3. Results

During the above-mentioned five-year period, we used VATS as an adjunct to the surgical management of 13 patients with Pancoast tumors. They were 10 men and three women with median age of 65 years (range: 39–75 years). Table 1 summarizes the patient characteristics. Preoperative staging, according to the 2009 revised TNM classification was IIB ($n=4$) and IIIA ($n=9$). Although preoperative evaluation with CT and MRI-scans identified the possible candidates for surgical resection and the type of surgical approach, the use of thoracoscopy to examine the extent of the tumor on the thoracic chest-wall, the thoracic inlet, the lung, the mediastinum, as well as the level of subclavian vessels involvement and presence of carcinosis, was crucial in the clinical decision-making. VATS led to non-surgical therapy in three patients due to pleural carcinosis, which had not been detected with preoperative examinations. In these patients, pleural involvement was confirmed by biopsy and intraoperative frozen sections and all of them underwent talc pleurodesis. In the remaining 10 patients, seven lobectomies and three wedge resections with an en bloc chest-wall resection and mediastinal lymphadenectomy were performed. Patients who underwent wedge resection were unfit for lobectomy and were heavy smokers. All of them had severe pulmonary disease with $FEV_1 \leq 50\%$ predicted. The surgical approach was a transmanubrial L-shaped incision ($n=1$), a posterior thoracotomy ($n=8$), and a combined transmanubrial and posterior thoracotomy ($n=1$). In one case, the subclavian artery was involved by the tumor, and was replaced by a polytetrafluoroethylene (PTFE) graft. In two patients, there was tumor involvement of the subclavian vein. The veins were resected without reconstruction. In one patient, a liquoral fistula was treated intraoperatively. In another patient, a partial vertebrectomy (T2–T3) and spinal stabilization was performed by a neurosurgical team due to vertebral body involvement. This was the only patient to receive a blood transfusion. The average operating time of the patients who underwent lung resection was 200 min (range: 185–280 min), and R0 resection was achieved in all patients ($n=10$). The average blood loss was 325 ml (range: 250–1200 ml). There was no mortality up to 90 days postoperatively. The postoperative course was complicated in three patients by pneumonia. The median length of hospital stay was nine days (range: 8–30 days). After a median follow-up of 18.5 months (range: 6–44 months), no patient developed a local recurrence.

Table 1. Demographic and operative details of the cohort of patients in this study

	Age	Gender	Symptoms	Co-morbidity	Neoadjuvant chemoradiation	Access	Operation	Operative time in minutes	Blood loss	Intensive care stay	Hospital stay and discharge	Complications	Histological type	Follow-up data
1	59	M	Pain in the shoulder and in the arm	Smoker Hypertension	CR	Posterior	I, II, III rib resection, upper R lobectomy, subclavian artery graft, ML	190	480	2	10	No	Adenocarcinoma	Dead at 41 months due to liver and brain metastases
2	39	M	Back and chest pain, weakness and numbness C8/TH1-2	Smoker	CR	Posterior	I, II, III, IV rib resection, upper L wedge-resection, ML	185	350	3	30	Liquoral fistula, pneumonia	Epidermoid carcinoma	Dead at 25 months due to liver and bone metastases
3	67	F	Upper arm pain, Horner's syndrome	Smoker Hypertension COPD	CR	Thoracoscopy	L explorative thoracoscopy	20	0	0	3	No	Adenocarcinoma	Dead at 12 months due to liver and bone metastases
4	71	M	Pain in the shoulder and in the arm radiating to the upper anterior chest-wall	Smoker Hypertension	CR	Posterior	I, II, III, rib resection, upper L lobectomy, ML	190	250	3	10	No	Epidermoid carcinoma	Dead at 38 months due to acute myeloid leukemia
5	72	M	Pain in the shoulder and in the arm	Hypertension Diabetes mellitus		Posterior	I, II, III, rib resection, upper L lobectomy, ML	200	400	4	9	No	Epidermoid carcinoma	Alive at 44 months postoperatively
6	75	M	Pain in the shoulder	Smoker Hypertension COPD	CR	Thoracoscopy	R explorative thoracoscopy	25	0	0	3	No	Adenocarcinoma	Dead at 15 months for bilateral lung metastases
7	48	M	Back chest pain, Horner's syndrome	Smoker	CR	Posterior	I, II, III, IV rib resection, upper L lobectomy, partial vertebrectomy D2, D3, spinal stabilization, ML	280	1200	3	20	Pneumonia	Epidermoid carcinoma	Alive at 19 months postoperatively
8	55	M	Weakness and numbness C8/TH1-2	Smoker Hypertension COPD	CR	Posterior	I, II, III, rib resection, upper L lobectomy, ML	240	300	2	9	No	Adenocarcinoma	Alive at 18 months postoperatively
9	63	M	Pain in the shoulder and in the arm	Smoker	CR	Posterior	I, II, III, IV rib resection, upper R lobectomy, ML	240	260	1	9	Pneumonia	Epidermoid carcinoma	Alive at 15 months postoperatively
10	66	M	Pain radiating the upper	Smoker Hypertension	CR	Combined	I, II, III, rib resection,	210	380	1	9	No	Epidermoid carcinoma	Alive at 15 months

Table 1. (*Continued*)

	Age	Gender	Symptoms	Co-morbidity	Neoadjuvant chemoradiation	Access	Operation	Operative time in minutes	Blood loss	Intensive care stay	Hospital stay and discharge	Complications	Histological type	Follow-up data
			anterior chest-wall, venous thrombosis	COPD			upper R lobectomy, ML							postoperatively
11	65	M	Pain in the shoulder and in the arm	Smoker COPD	CR	Posterior	I, II, III rib resection, upper R wedge-resection, ML	190	300	3	10	No	Adenocarcinoma	Alive at 14 months postoperatively
12	70	F	Pain in the shoulder	Hypertension	CR	Thoracoscopy	L explorative thoracoscopy	25	0	0	4	No	Adenocarcinoma	Alive at 10 months postoperatively
13	47	M	Parasthesia, pain radiating to the upper limb and to the shoulder, diaphragmatic palsy	Smoker Diabetes	CR	Anterior	I, II rib resection, upper R wedge-resection, ML	200	250	4	8	No	Adenocarcinoma	Alive at 6 months postoperatively

CR, chemoradiation; COPD, chronic obstructive pulmonary disease; ML, mediastinal lymphadenectomy.

4. Discussion

Induction chemoradiation followed by surgery is presently the gold standard treatment for patients with Pancoast tumors [4–6]. Tumor-free resection is mandatory to obtain improved survival rates. The use of VATS in the treatment of Pancoast tumors has only occasionally been reported in the English literature. Beshay et al. [7] used thoracoscopy to obtain the diagnosis by biopsy in a patient with Pancoast tumor; Koshiko et al. [8] reported a case of video-assisted en bloc resection of a Pancoast tumor, while Vallières et al. [9] reported the possible use of thoracoscopy for the staging and assessment of resectability only of Pancoast tumors. Roviaro et al. [10] suggested routine use of VATS as intraoperative staging for lung cancer and for confirmation of resectability of the lesion.

Fadel et al. [11] reported the en bloc resection of lung cancer that had invaded the thoracic inlet and intervertebral foramina with a combined approach. This procedure was conducted in accordance with the approach described by Dartevelle et al. [12] in combination with a posterolateral thoracotomy.

Koshiko et al. [8] presented a case report of the en bloc resection of a Pancoast tumor that was treated with an anterior transcervical approach and assisted thoracoscopic procedure in the supine position, which was then converted to a posterior thoracotomy to complete the operation without video-assistance. In our series, the case of combined anterior and posterior approach was performed entirely with video-assistance and without changing the position of the patient. Unlike Fadel et al. [11], we treated our patient who needed a combined approach with the patient placed only in the lateral decubitus position. In this case, to facilitate the anterior approach, the operative bed can be rotated, in order to transfer the patient to a position that was at a 20–30° angle to the horizontal plane. We were able to treat the only patient of our series with vertebral body involvement with an en bloc resection of the lung cancer invading the thoracic inlet without changing the patient to the prone position. Martinod et al. [13] reported that different surgical approaches did not influence the five-year survival rate. Consequently, we believe that each of these approaches is suitable for Pancoast resection, but we strongly believe that the approach has to be tailored to the single patient and that video-assistance may be of help in the decision of the optimal access. Of note, it was possible to proceed with the use of VATS even in the presence of adhesions between the lung and pleura, which was the case in two patients.

Limitations of the study include the fact that patients underwent neoadjuvant chemoradiotherapy in four different oncological centers and that operations were performed in three different centers. However, all surgeries were performed by the same two surgeons. Another limitation was that this relatively small series of patients was a non-randomized cohort study. It would be interesting to conduct this technique in a randomized study with a larger series against the use of thoracotomy alone.

The excellent visualization of anatomical structures of thoracic inlet due to the light and magnification offered by VATS allows all member of the team to follow in detail the

surgical steps and helps the surgeon to confirm or change the surgical strategy intraoperatively by observing the chest-wall invasion from a different perspective. Of course, the surgeon should be familiar with all of the surgical approaches to Pancoast tumors. The use of VATS resulted in all cases in this series in a less invasive surgery including a preserved latissimus dorsi muscle, a reduced extent of the thoracotomy and postoperative chest trauma. Additionally, the fact that the arm was prepped and protected by drapes enabled us to keep the patient in the same position after the exploration of the chest cavity for any of the three approaches that could be chosen.

In conclusion, although limited, our experience suggests that the use of VATS as an adjunct to standard surgical treatment of Pancoast tumors is feasible and safe. Furthermore, we were pleased to observe that the use of VATS in these patients provided a useful teaching tool for the education of residents, fellows and junior surgeons.

References

[1] Pancoast HK. Superior pulmonary sulcus tumour: tumor characterized by pain, Horner's syndrome, destruction of bone and atrophy of hand muscles. J Am Med Assoc 1932;99:1391–1396.

[2] Detterbeck FC. Pancoast (superior sulcus) tumors. Ann Thorac Surg 1997;63:1810–1818.

[3] Grunenwald D, Spaggiari L. Transmanubrial osteomuscular sparing approach for apical chest tumors. Ann Thorac Surg 1997;63:563–566.

[4] Rusch VW, Giroux DJ, Kraut MJ, Crowley J, Hazuka M, Johnson D, Goldberg M, Detterbeck F, Shepherd F, Burkes R, Winton T, Deschamps C, Livingstone R, Gandara D. Induction chemoradiation and surgical resection for non-small-cell lung carcinomas of the superior sulcus: initial results of Southwest Oncology Group Trial 9416 (Intergroup Trial 0160). J Thorac Cardiovasc Surg 2001;121:472–483.

[5] Rusch VW, Giroux DJ, Kraut MJ, Crowley J, Hazuka M, Winton T, Johnson DH, Shulman L, Shepherd F, Deschamps C, Livingston RB, Gandara D. Induction chemoradiation and surgical resection for superior sulcus non-small-cell lung carcinomas: long-term results of Southwest Oncology Group Trial 9416 (Intergroup Trial 0160). J Clin Oncol 2007;25:313–318.

[6] Tamura M, Hoda MA, Klepetko W. Current treatment paradigms of superior sulcus tumours. Eur J Cardiothorac Surg 2009;36:747–753.

[7] Beshay M, Roth T, Stein RM, Schimd RA. Tuberculosis presenting as Pancoast tumor. Ann Thorac Surg 2003;76:1733–1735.

[8] Koshiko S, Inaba M, Uchida H, Saitoh Y. En bloc resection for apical invading lung cancer under anterior transcervical approach and assisted thoracoscopic procedure. Kyobu Geka 2008;61:379–382.

[9] Vallières E, Karmy-Jones R, Mulligan MS, Wood DE. Pancoast tumors. Curr Probl Surg 2001;38:306–376.

[10] Roviaro G, Varoli F, Rebuffat C, Vergani C, Maciocco M, Scalambra SM, Sonnino D, Gozi G. Videothoracoscopic staging and treatment of lung cancer. Ann Thorac Surg 1995;59:971–974.

[11] Fadel E, Missenard G, Chapelier A, Mussot S, Leroy-Ladurie F, Cerrina J, Dartevelle P. En bloc resection of non-small cell lung cancer invading the thoracic inlet and intervertebral foramina. J Thorac Cardiovasc Surg 2002;123:676–685.

[12] Dartevelle PG, Chapelier AR, Macchiarini P, Lenot B, Cerrina J, Ladurie FL, Parquin FJ, Lafont D. Anterior transcervical-thoracic approach for radical resection of lung tumors invading the thoracic inlet. J Thorac Cardiovasc Surg 1993;105:1025–1034.

[13] Martinod E, D'Audiffret A, Thomas P, Wurtz AJ, Dahan M, Riquet M, Dujon A, Jancovici R, Giudicelli R, Fuentes P, Azorin JF. Management of superior sulcus tumors: experience with 139 cases treated by surgical resection. Ann Thorac Surg 2002;73:1534–1539; discussion 1539–1540.