11209

23

"NONANATOMIC THORACOSCOPIC WEDGE RESECTION FOR DIFFUSE LUNG DISEASE AND INDETERMINATE LUNG NODULE" World J. Surg. 26, 43-48,2002

Publicación que presenta **el Dr. Luis Marcelo Argote Greene** a manera de tesis para el grado de Especialista en Cirugía General

2002

DR. LUIS F. USCANGA DOMÍNGUEZ
Director de Enseñanza, INCMNSZ

INCMNSZ
INSTITUTO NACIONAL
DE CIENCIAS MEDICAS Y NUTRICION
"DR. SALVADOR ZUBIRAN"
DIRECCION DE ENSEÑANZA
México, D.F.

DR. HECTOR OROZCO ZEPEDA
Profesor Titular del Curso de
Especialización en Cirugía General,
INCMNSZ

INST. NACIONAL DE CIENCIAS
MEDICAS Y NUTRICION
"SALVADOR ZUBIRAN"

DIRECCION DE CIRUGIA

VNIVERSIDAD NACIONAL
AVTÓNOMA DE
MEXICO

FACULTAD DE MEDICINA
DIVISION DE ESTUDIOS DE POSGRADO E INVESTIGACION

SUBDIVISION DE ESPECIALIZACIONES MEDICAS

OFICIO FMED/SEM/1634/2002

ASUNTO: Autorización del trabajo de investigación del Dr. Luis Marcelo Argote Greene.

DR. CESAR AUGUSTO COLINA RAMÍREZ
SECRETARIO DE SERVICIOS ESCOLARES
DE LA FACULTAD DE MEDICINA
Presente.

Estimado Dr. Colina Ramírez:

Me permito informar a usted que el **Dr. Luis Marcelo Argote Greene,** alumno del curso de especialización en **Cirugía General** en el **Instituto Nacional de Ciencias Médicas y de la Nutrición "Dr. Salvador Zubirán**", presenta el trabajo de investigación intitulado ***"Nonanatomic Thoracoscopic Wedge Resection for Diffuse Lung Disease and Indeterminate Pulmonary Nodule".***

De conformidad con el artículo 21 capítulo 5º. de las Normas Operativas del Plan Unico de Especializaciones Médicas (PUEM) se considera que cumple con los requisitos para validarlo como el trabajo formal de Investigación que le otorga el derecho a la diplomación como especialista.

Sin otro particular de momento, reciba un cordial saludo.

Atentamente
"POR MI RAZA HABLARA EL ESPIRITU"
Cd. Universitaria, D. F. a 29 de agosto del 2002

JEFE DE LA SUBDIVISION

DR. LEOBARDO C. RUIZ PEREZ

LRP*ajr.

WORLD Journal of SURGERY

Official Journal of the International Society of Surgery/ Société Internationale de Chirurgie (ISS/SIC) • International Association of Endocrine Surgeons (IAES) • International Association for the Surgery of Trauma and Surgical Intensive Care (IATSIC) • International Association for Surgical Metabolism and Nutrition (IASMEN) • Breast Surgery International (BSI) • International Federation of Surgical Colleges (IFSC)

Volume 26, Number 1, 2002

Contents continued

Springer

World J. Surg. 26, 43–48, 2002
DOI: 10.1007/s00268-001-0179-0

WORLD Journal of SURGERY

Nonanatomic Thoracoscopic Wedge Resection for Diffuse Lung Disease and Indeterminate Pulmonary Nodule

Patricio Santillan-Doherty, M.D., Jennifer Cuellar-Rodríguez, M.D., Luis Marcelo Argote-Greene, M.D., Jorge Hernández-Calleros, M.D.

Thoracic Surgical Service, Department of Surgery, National Institute of Medical Sciences and Nutrition "Salvador Zubirán", Vasco de Quiroga 15, Tlalpan 14000, D.F., Mexico

Published Online: November 22, 2001

Abstract. Video technology has revolutionized thoracoscopy dramatically, considerably increasing its indications. The clinical charts of patients who underwent a video-thoracoscopic procedure during a 6-year period were reviewed. Any patient in whom lung wedge resection for diffuse disease or an indeterminate nodule was performed met the inclusion criteria. Early and long-term outcomes were analyzed. A total of 310 thoracoscopic procedures were performed in the 250 patients reviewed. Of these patients, 60 presented with diffuse lung disease and 71 with an indeterminate pulmonary nodule. The total morbidity among diffuse disease patients was 5% (one intercostal vessel hemorrhage and two air leaks). Overall mortality for this group was 11% and was related to previous respiratory status and underlying disease. Patients not requiring preoperative mechanical ventilation ended up requiring it postoperatively, for a crossover rate of 23%. There was no morbidity or mortality in patients who did not require mechanical ventilation. The therapeutic impact index (defined as the total number of patients divided by the patients in whom initiation or withdrawal of specific treatment was due to the biopsy result) for diffuse lung disease was 0.9. Regarding lung nodule resection, early morbidity was present in one patient, who developed a persistent air leak. Late morbidity was present in three patients, who developed persistent intercostal pain. Total morbidity was 5.6%. No mortality was observed for this group. Nonanatomic wedge resection via video-thoracoscopy for diffuse pulmonary disease and indeterminate lung nodule is feasible using minimally invasive methods. Morbidity and mortality are related to the underlying disease and the respiratory status; they are not necesarily due to the procedure.

With the development of proper video and instrumentation equipment, the indications for video-assisted thoracic procedures have been steadily increasing. Pleural effusion and pneumothorax were among the first indications for thoracoscopy even before the introduction of video-endoscopic methods [1–3]. Open lung biopsy for diffuse pulmonary diseases by means of a nonanatomic wedge resection is indicated when other methods do not allow a satisfactory diagnosis. The presence of an indeterminate pulmonary nodule is another frequently encountered problem, which raises the question regarding the possibility of carcinoma. These two scenarios are well suited for endoscopic resection by video-thoracoscopy using specially designed stapling devices [4].

Correspondence to: P. Santillan-Doherty, M.D.

Resectional thoracoscopic biopsy of lung tissue for diffuse problems enables the surgeon to obtain an adequate specimen after having thoroughly examined the pleural cavity and the lung surface. On the other hand, lung nodule resection, although performed as a diagnostic method, can end up being a therapeutic procedure when benign disease is encountered or, in the case of malignancy, when pulmonary function precludes further resection of lung parenchyma. In any case, the patient is offered a procedure performed under minimally invasive conditions with less morbidity than that encountered after formal thoracotomy. When non-small-cell carcinoma is encountered, conversion to an open anatomic lung resection is indicated; however, video-thoracoscopic lobectomy or pneumonectomy is possible and has been described [5].

The purpose of the present study was to review our experience with non-anatomic wedge resection for diffuse pulmonary disease and indeterminate lung nodules performed via video-thoracoscopy.

Materials and Methods

The clinical charts of patients submited to video-thoracoscopy during the period January 1993 to June 1999 were reviewed. Patients in whom a nonanatomic endoscopic lung resection—biopsy for diffuse disease or wedge resection of a lung nodule—were included. The clinical characteristics and the final diagnoses were recorded. The postoperative course and long-term outcome were analyzed regarding duration of pleural drainage, the presence of complications, and the use of narcotics and nonsteroidal antiinflammatory drugs (NSAIDs) for pain control.

All patients were operated on under general anesthesia, and a double-lumen endotracheobronchial tube was introduced for one-lung ventilation. Monitoring included continuous pulse oximetry and end-tidal capnography. The lateral decubitus position was established with the operating table slightly flexed to increase the intercostal spaces and lower the pelvis. The first port of entry to the pleural space was usually established through the sixth intercostal space at the mid-axillary level; after thorough evaluation of

World J. Surg. 26, 43–48, 2002
DOI: 10.1007/s00268-001-0179-0

WORLD Journal of SURGERY

Nonanatomic Thoracoscopic Wedge Resection for Diffuse Lung Disease and Indeterminate Pulmonary Nodule

Patricio Santillan-Doherty, M.D., Jennifer Cuellar-Rodríguez, M.D., Luis Marcelo Argote-Greene, M.D., Jorge Hernández-Calleros, M.D.

Thoracic Surgical Service, Department of Surgery, National Institute of Medical Sciences and Nutrition "Salvador Zubirán", Vasco de Quiroga 15, Tlalpan 14000, D.F., Mexico

Published Online: November 22, 2001

Abstract. Video technology has revolutionized thoracoscopy dramatically, considerably increasing its indications. The clinical charts of patients who underwent a video-thoracoscopic procedure during a 6-year period were reviewed. Any patient in whom lung wedge resection for diffuse disease or an indeterminate nodule was performed met the inclusion criteria. Early and long-term outcomes were analyzed. A total of 310 thoracoscopic procedures were performed in the 250 patients reviewed. Of these patients, 60 presented with diffuse lung disease and 71 with an indeterminate pulmonary nodule. The total morbidity among diffuse disease patients was 5% (one intercostal vessel hemorrhage and two air leaks). Overall mortality for this group was 11% and was related to previous respiratory status and underlying disease. Patients not requiring preoperative mechanical ventilation ended up requiring it postoperatively, for a crossover rate of 23%. There was no morbidity or mortality in patients who did not require mechanical ventilation. The therapeutic impact index (defined as the total number of patients divided by the patients in whom initiation or withdrawal of specific treatment was due to the biopsy result) for diffuse lung disease was 0.9. Regarding lung nodule resection, early morbidity was present in one patient, who developed a persistent air leak. Late morbidity was present in three patients, who developed persistent intercostal pain. Total morbidity was 5.6%. No mortality was observed for this group. Nonanatomic wedge resection via video-thoracoscopy for diffuse pulmonary disease and indeterminate lung nodule is feasible using minimally invasive methods. Morbidity and mortality are related to the underlying disease and the respiratory status; they are not necesarily due to the procedure.

With the development of proper video and instrumentation equipment, the indications for video-assisted thoracic procedures have been steadily increasing. Pleural effusion and pneumothorax were among the first indications for thoracoscopy even before the introduction of video-endoscopic methods [1–3]. Open lung biopsy for diffuse pulmonary diseases by means of a nonanatomic wedge resection is indicated when other methods do not allow a satisfactory diagnosis. The presence of an indeterminate pulmonary nodule is another frequently encountered problem, which raises the question regarding the possibility of carcinoma. These two scenarios are well suited for endoscopic resection by video-thoracoscopy using specially designed stapling devices [4].

Correspondence to: P. Santillan-Doherty, M.D.

Resectional thoracoscopic biopsy of lung tissue for diffuse problems enables the surgeon to obtain an adequate specimen after having thoroughly examined the pleural cavity and the lung surface. On the other hand, lung nodule resection, although performed as a diagnostic method, can end up being a therapeutic procedure when benign disease is encountered or, in the case of malignancy, when pulmonary function precludes further resection of lung parenchyma. In any case, the patient is offered a procedure performed under minimally invasive conditions with less morbidity than that encountered after formal thoracotomy. When non-small-cell carcinoma is encountered, conversion to an open anatomic lung resection is indicated; however, video-thoracoscopic lobectomy or pneumonectomy is possible and has been described [5].

The purpose of the present study was to review our experience with non-anatomic wedge resection for diffuse pulmonary disease and indeterminate lung nodules performed via video-thoracoscopy.

Materials and Methods

The clinical charts of patients submited to video-thoracoscopy during the period January 1993 to June 1999 were reviewed. Patients in whom a nonanatomic endoscopic lung resection—biopsy for diffuse disease or wedge resection of a lung nodule—were included. The clinical characteristics and the final diagnoses were recorded. The postoperative course and long-term outcome were analyzed regarding duration of pleural drainage, the presence of complications, and the use of narcotics and nonsteroidal antiinflammatory drugs (NSAIDs) for pain control.

All patients were operated on under general anesthesia, and a double-lumen endotracheobronchial tube was introduced for one-lung ventilation. Monitoring included continuous pulse oximetry and end-tidal capnography. The lateral decubitus position was established with the operating table slightly flexed to increase the intercostal spaces and lower the pelvis. The first port of entry to the pleural space was usually established through the sixth intercostal space at the mid-axillary level; after thorough evaluation of

World J. Surg. 26, 43–48, 2002
DOI: 10.1007/s00268-001-0179-0

WORLD Journal of SURGERY

Nonanatomic Thoracoscopic Wedge Resection for Diffuse Lung Disease and Indeterminate Pulmonary Nodule

Patricio Santillan-Doherty, M.D., Jennifer Cuellar-Rodríguez, M.D., Luis Marcelo Argote-Greene, M.D., Jorge Hernández-Calleros, M.D.

Thoracic Surgical Service, Department of Surgery, National Institute of Medical Sciences and Nutrition "Salvador Zubirán", Vasco de Quiroga 15, Tlalpan 14000, D.F., Mexico

Published Online: November 22, 2001

Abstract. Video technology has revolutionized thoracoscopy dramatically, considerably increasing its indications. The clinical charts of patients who underwent a video-thoracoscopic procedure during a 6-year period were reviewed. Any patient in whom lung wedge resection for diffuse disease or an indeterminate nodule was performed met the inclusion criteria. Early and long-term outcomes were analyzed. A total of 310 thoracoscopic procedures were performed in the 250 patients reviewed. Of these patients, 60 presented with diffuse lung disease and 71 with an indeterminate pulmonary nodule. The total morbidity among diffuse disease patients was 5% (one intercostal vessel hemorrhage and two air leaks). Overall mortality for this group was 11% and was related to previous respiratory status and underlying disease. Patients not requiring preoperative mechanical ventilation ended up requiring it postoperatively, for a crossover rate of 23%. There was no morbidity or mortality in patients who did not require mechanical ventilation. The therapeutic impact index (defined as the total number of patients divided by the patients in whom initiation or withdrawal of specific treatment was due to the biopsy result) for diffuse lung disease was 0.9. Regarding lung nodule resection, early morbidity was present in one patient, who developed a persistent air leak. Late morbidity was present in three patients, who developed persistent intercostal pain. Total morbidity was 5.6%. No mortality was observed for this group. Nonanatomic wedge resection via video-thoracoscopy for diffuse pulmonary disease and indeterminate lung nodule is feasible using minimally invasive methods. Morbidity and mortality are related to the underlying disease and the respiratory status; they are not necesarily due to the procedure.

With the development of proper video and instrumentation equipment, the indications for video-assisted thoracic procedures have been steadily increasing. Pleural effusion and pneumothorax were among the first indications for thoracoscopy even before the introduction of video-endoscopic methods [1–3]. Open lung biopsy for diffuse pulmonary diseases by means of a nonanatomic wedge resection is indicated when other methods do not allow a satisfactory diagnosis. The presence of an indeterminate pulmonary nodule is another frequently encountered problem, which raises the question regarding the possibility of carcinoma. These two scenarios are well suited for endoscopic resection by video-thoracoscopy using specially designed stapling devices [4].

Correspondence to: P. Santillan-Doherty, M.D.

Resectional thoracoscopic biopsy of lung tissue for diffuse problems enables the surgeon to obtain an adequate specimen after having thoroughly examined the pleural cavity and the lung surface. On the other hand, lung nodule resection, although performed as a diagnostic method, can end up being a therapeutic procedure when benign disease is encountered or, in the case of malignancy, when pulmonary function precludes further resection of lung parenchyma. In any case, the patient is offered a procedure performed under minimally invasive conditions with less morbidity than that encountered after formal thoracotomy. When non-small-cell carcinoma is encountered, conversion to an open anatomic lung resection is indicated; however, video-thoracoscopic lobectomy or pneumonectomy is possible and has been described [5].

The purpose of the present study was to review our experience with non-anatomic wedge resection for diffuse pulmonary disease and indeterminate lung nodules performed via video-thoracoscopy.

Materials and Methods

The clinical charts of patients submited to video-thoracoscopy during the period January 1993 to June 1999 were reviewed. Patients in whom a nonanatomic endoscopic lung resection—biopsy for diffuse disease or wedge resection of a lung nodule—were included. The clinical characteristics and the final diagnoses were recorded. The postoperative course and long-term outcome were analyzed regarding duration of pleural drainage, the presence of complications, and the use of narcotics and nonsteroidal antiinflammatory drugs (NSAIDs) for pain control.

All patients were operated on under general anesthesia, and a double-lumen endotracheobronchial tube was introduced for one-lung ventilation. Monitoring included continuous pulse oximetry and end-tidal capnography. The lateral decubitus position was established with the operating table slightly flexed to increase the intercostal spaces and lower the pelvis. The first port of entry to the pleural space was usually established through the sixth intercostal space at the mid-axillary level; after thorough evaluation of

the pleural cavity and ensurance of adequate lung collapse, second and third portals were established depending on the location of the lung parenchyma to be resected. All portals were established by an initial 1 cm skin incision followed by blunt dissection with a forceps up to the parietal pleura and finally introduction of a 10 mm metallic trocar. Once the appropriate portion of lung to be resected was identified, a standard ringed forceps was introduced through one of the portals, and the lung parenchyma was fixed using minimal pressure to avoid crushing lung tissue. A commercially available endostapler (Autosuture EndoGIA 30v or Ethicon Endopath 35) was introduced through one of the other portals (without the trocar) using a rotatory movement to dilate the entry port partially. Once inside the pleural cavity, the stapler was opened and the lung positioned between its mandibles; afterward the stapler was closed and fired. Opening the stapler was done with care, always viewing both sides of the cut and the stapled lung parenchyma. Appropriate numbers of staple lines were used to complete the resection. On average, the lung biopsy required two or three staple lines, and nodule resection required four to six. The resected wedge was then extracted from the pleural cavity and inspected; if necessary, appropriate specimens were taken for microbiologic culture, but most of the specimen was sent to the pathology laboratory for histologic examination. Finally, the lung was inspected for blood or air leaks before and after reinsufflation; a single 28F or 32F chest tube was inserted through the lowest chest port and connected to a prefabricated commercial water seal system with suction (15–18 cm H_2O). The other ports were closed with a single absorbable suture in the muscle fascia and subcutaneous tissue, and a subdermic absorbable suture was used for the skin incision. Recently, selected patients have been managed without postoperative chest drainage; selection criteria include minimal pleuropulmonary trauma during dissection, full lung reexpansion observed immediately after the procedure, absence of an air leak, and absence of increased lung retractility (i.e., lung fibrosis). In these patients all ports were closed as described except one, through which a long latex 24F to 26F catheter was introduced in an apico-anterior position. After lung reexpansion and during forced insufflation (up to 30 cm H_2O) performed by the anesthesiologist, the pleural cavity was continuously aspirated through the chest catheter while being extracted, and the port suture was closed. Patients were observed for an average of 1 hour in the recovery unit before being sent to the ward.

Results

A total of 310 thoracoscopic procedures were performed on 250 patients who submitted to video-thoracoscopy for several indications (Tables 1, 2). The most frequent indications were diffuse lung disease (n = 60 patients) and an indeterminate pulmonary nodule (n = 71).

Diffuse Lung Disease

Sixty patients with diffuse lung disease underwent thoracoscopic resectional biopsy. In all, the procedure was indicated when the results of other tests, such as bronchoalveolar lavage and transbronchial biopsy, were not conclusive. Of these patients, 48 (81%) presented with acute or subacute diffuse pulmonary infiltrates and a high immunologic risk status (renal transplant recipient 7, human immunodeficiency virus infection 12, rheumatologic disease with immunosuppressive treatment 14, antineoplasic chemotherapy 15). The remaining 12 patients presented with pulmonary infiltrates and no immunologic risk.

Regarding the respiratory status, patients were divided into three groups according to the presence of hypoxemia ($PaO_2 < 50$ mmHg on room air) and the need of mechanical ventilation or oxygen supplementation (Table 3). Preoperatively, most patients had a certain degree of hypoxemia but did not require mechanical ventilation; however, six of these patients eventually required mechanical ventilation immediately after surgery, for a 23% "crossover" rate (6/26 patients with hypoxemia who ended up requiring mechanical ventilation postoperatively). Mortality was confined to the group of patients for whom mechanical ventilation became necessary (7/29 patients) and was related to progressive pulmonary failure and the development of multiorgan failure. Overall mortality for lung resection performed because of diffuse disease was 11.6%. None of the patients with normal preoperative

Table 1. Indication for thoracoscopy in 250 patients.

Indication	No.
Lung nodule	71
Diffuse lung disease	60
Pleural effusion	53
Lung tumor	19
Empyema	14
Pneumothorax	11
Subaortic adenopathy	6
Pericardial effusion	3
Chest wall tumor	3
Pleural tumor	4
Mediastinal tumor	2
Sympathectomy	2
Hemothorax	2

Table 2. Video-thoracoscopic procedures performed on 250 patients.

Procedure	No.
Lung procedures (n = 170)	
Lung nodule resection	81
Lung wedge biopsy	63
Direct biopsy with large-core needle	16
Bullae resection	7
Lobectomy	2
Persistent air leak suture	1
Pleural procedures (n = 104)	
Pleural biopsy	36
Talc pleurodesis	30
Decortication	14
Pleuroscopy	6
Pleural abrasion	6
Adhesion resection	4
Pleural tumor resection	4
Pleurectomy	3
Pleurodiaphragmatic suture	1
Miscellaneous procedures (n = 36)	
Mediastinal adenopathy biopsy	12
Pericardial biopsy/window	13
Enteric cyst resection	3
Thoracic sympathectomy	3
Subphrenic abscess drainage	3
Thymectomy	1
Intercostal artery ligation	1

the pleural cavity and ensurance of adequate lung collapse, second and third portals were established depending on the location of the lung parenchyma to be resected. All portals were established by an initial 1 cm skin incision followed by blunt dissection with a forceps up to the parietal pleura and finally introduction of a 10 mm metallic trocar. Once the appropriate portion of lung to be resected was identified, a standard ringed forceps was introduced through one of the portals, and the lung parenchyma was fixed using minimal pressure to avoid crushing lung tissue. A commercially available endostapler (Autosuture EndoGIA 30v or Ethicon Endopath 35) was introduced through one of the other portals (without the trocar) using a rotatory movement to dilate the entry port partially. Once inside the pleural cavity, the stapler was opened and the lung positioned between its mandibles; afterward the stapler was closed and fired. Opening the stapler was done with care, always viewing both sides of the cut and the stapled lung parenchyma. Appropriate numbers of staple lines were used to complete the resection. On average, the lung biopsy required two or three staple lines, and nodule resection required four to six. The resected wedge was then extracted from the pleural cavity and inspected; if necessary, appropriate specimens were taken for microbiologic culture, but most of the specimen was sent to the pathology laboratory for histologic examination. Finally, the lung was inspected for blood or air leaks before and after reinsufflation; a single 28F or 32F chest tube was inserted through the lowest chest port and connected to a prefabricated commercial water seal system with suction (15–18 cm H_2O). The other ports were closed with a single absorbable suture in the muscle fascia and subcutaneous tissue, and a subdermic absorbable suture was used for the skin incision. Recently, selected patients have been managed without postoperative chest drainage; selection criteria include minimal pleuropulmonary trauma during dissection, full lung reexpansion observed immediately after the procedure, absence of an air leak, and absence of increased lung retractility (i.e., lung fibrosis). In these patients all ports were closed as described except one, through which a long latex 24F to 26F catheter was introduced in an apico-anterior position. After lung reexpansion and during forced insufflation (up to 30 cm H_2O) performed by the anesthesiologist, the pleural cavity was continuously aspirated through the chest catheter while being extracted, and the port suture was closed. Patients were observed for an average of 1 hour in the recovery unit before being sent to the ward.

Results

A total of 310 thoracoscopic procedures were performed on 250 patients who submitted to video-thoracoscopy for several indications (Tables 1, 2). The most frequent indications were diffuse lung disease (n = 60 patients) and an indeterminate pulmonary nodule (n = 71).

Diffuse Lung Disease

Sixty patients with diffuse lung disease underwent thoracoscopic resectional biopsy. In all, the procedure was indicated when the results of other tests, such as bronchoalveolar lavage and transbronchial biopsy, were not conclusive. Of these patients, 48 (81%) presented with acute or subacute diffuse pulmonary infiltrates and a high immunologic risk status (renal transplant recipient 7, human immunodeficiency virus infection 12, rheumatologic disease with immunosuppressive treatment 14, antineoplasic chemotherapy 15). The remaining 12 patients presented with pulmonary infiltrates and no immunologic risk.

Regarding the respiratory status, patients were divided into three groups according to the presence of hypoxemia ($PaO_2 < 50$ mmHg on room air) and the need of mechanical ventilation or oxygen supplementation (Table 3). Preoperatively, most patients had a certain degree of hypoxemia but did not require mechanical ventilation; however, six of these patients eventually required mechanical ventilation immediately after surgery, for a 23% "crossover" rate (6/26 patients with hypoxemia who ended up requiring mechanical ventilation postoperatively). Mortality was confined to the group of patients for whom mechanical ventilation became necessary (7/29 patients) and was related to progressive pulmonary failure and the development of multiorgan failure. Overall mortality for lung resection performed because of diffuse disease was 11.6%. None of the patients with normal preoperative

Table 1. Indication for thoracoscopy in 250 patients.

Indication	No.
Lung nodule	71
Diffuse lung disease	60
Pleural effusion	53
Lung tumor	19
Empyema	14
Pneumothorax	11
Subaortic adenopathy	6
Pericardial effusion	3
Chest wall tumor	3
Pleural tumor	4
Mediastinal tumor	2
Sympathectomy	2
Hemothorax	2

Table 2. Video-thoracoscopic procedures performed on 250 patients.

Procedure	No.
Lung procedures (n = 170)	
Lung nodule resection	81
Lung wedge biopsy	63
Direct biopsy with large-core needle	16
Bullae resection	7
Lobectomy	2
Persistent air leak suture	1
Pleural procedures (n = 104)	
Pleural biopsy	36
Talc pleurodesis	30
Decortication	14
Pleuroscopy	6
Pleural abrasion	6
Adhesion resection	4
Pleural tumor resection	4
Pleurectomy	3
Pleurodiaphragmatic suture	1
Miscellaneous procedures (n = 36)	
Mediastinal adenopathy biopsy	12
Pericardial biopsy/window	13
Enteric cyst resection	3
Thoracic sympathectomy	3
Subphrenic abscess drainage	3
Thymectomy	1
Intercostal artery ligation	1

Table 3. Patients who underwent thoracoscopic lung resection biopsy for diffuse pulmonary disease, according to preoperative respiratory status and immunologic risk (n = 60).

Respiratory status	Immunologic high risk status[a]	Preop.	Postop.	Mortality	Air leak
Requiring mechanical ventilation (mv)	21	23	29	7 (25%)	2 (7%)
Hypoxemia not requiring mv (PaO_2 < 50 mmHg)	25	26	20	0	0
Normal oxygenation	2	11	11	0	0
Total	48	60	60	7 (11.6%)	2 (3.3%)

[a]Twelve patients with diffuse lung infiltrates but no history of immunologic risk.

Table 4. Histologic diagnosis in patients with diffuse lung disease: 63 biopsies in 60 patients.

Diagnosis	No.
Neumonitis/alveolitis	18
Primary lung neoplasia (n = 14)	
Adenocarcinoma	8
Squamous carcinoma	3
Small-cell lung carcinoma	3
Secondary neoplasia (n = 7)	
Papillary kidney	1
Bladder	1
Gastric adenocarcinoma	1
Melanoma	1
Follicular thyroid carcinoma	1
Sarcoma	1
Ovarian carcinoma	1
Tuberculosis	7
BOOP	6
Pulmonary fibrosis	5
Sarcoidosis	2
Metastatic calcinosis	1
Goodpasture syndrome	1
Aspergillosis	1
Eosinophilic pneumonia	1

BOOP: bronchiolitis obliterans-organizing pneumonia.

Table 5. Final diagnosis of lung resection for indetermined pulmonary nodule (81 nodules resected in 71 patients)

Diagnosis	No.
Granuloma	
Nonspecific	28
Tuberculous	15
Histoplasmoma	14
Coccidioidomycosis	2
Dirophilaria infection	1
Total	60 (74%)
Neoplasia	
Malignant neoplasia (11%)	
Squamous cell	3
Large cell	1
Small cell	1
Carcinoid	2
Lymphoma	1
Chondrosarcoma	1
Metastatic (4%)	
Kidney	3
Benign neoplasia (5%)	
Hamartoma	2
Chondroma	2
Total	16 (20%)
Other	
Interstitial lymphoid pneumonia	2
Lung infarction	1
Round atelectasis	1
Enteric cyst	1
Total	5 (6%)

oxygenation required postoperative mechanical ventilation (Table 3).

The morbidity rate in the group of patients submitted to lung resection for diffuse disease was 5%. One patient had a hemorrhage from a lacerated intercostal vessel that required surgical revision (2%). Two patients developed prolonged air leaks that required continuous pleural drainage (3%); both of these patients required mechanical ventilation with positive end-expiratory pressure above 10 cm H_2O. A third patient developed an air leak from the nonoperated contralateral lung owing to barotrauma. Because air leaks appeared only in patients requiring mechanical ventilation, the frequency of this complication in this subgroup increased to 7%.

In three patients more than one lung resection was performed; therefore a total of 63 lung specimens were available. The histologic diagnosis was established in all 63 lung biopsies (Table 4). The therapeutic impact of the tissue diagnosis for diffuse lung infiltrates was defined as the initiation or withdrawal of specific treatment because of the biopsy result. The therapeutic impact index was determined by dividing the number of patients with therapeutic change by the total number of patients. Thus lung biopsy for diffuse pulmonary disease results in a therapeutic impact index of 0.9 (initiation or modification of treatment in 56/60 patients).

Indeterminate Lung Nodule

Resection of an indeterminate lung nodule was deemed suitable for thoracoscopic approach when on review of the computed tomography (CT) scan the nodule was located in the outer third of the lung parenchyma or adjacent to a lung fissure. The size criterion limited the nodules to <4 cm in diameter. Also, an indication was established when radiology (chest radiography and CT) excluded a benign calcified appearance, previous radiographs were either unavailable or did not show the lesion, or there was no history of neoplasia. Using these criteria, thoracoscopic lung resection was indicated in 71 patients (Table 1). All of them underwent successful nodule resection, and more than one nodule was resected in six patients (two had three nodules and four had two nodules each). Thus a total of 81 nodules were resected (Table 5).

Most frequently, the nodule was found during the course of evaluating other medical problems (42/71): oncohematologic/rheumatologic disease (n = 14), chronic obstructive pulmonary disease (n = 11), chronic renal failure/transplantation (n = 5), human immunodeficiency virus (HIV) infection (n = 5), hepatic cirrhosis (n = 4), and diabetes mellitus (n = 3).

The mean operating time for this group was 47 ± 16 minutes. Follow-up has been 54 ± 5 months. Pleural drainage was required during mean of 1.7 days (range 0–5 days), and the last 20 cases have been managed without chest drainage. Postoperative analgesia was established with opiates for 1 day and NSAIDs for a mean of 3.8 ± 2 days.

Early and late morbidity was observed in this group of patients. Early morbidity was present in only one patient, who developed a persistent air leak that required resuturing. This patient presented with a 1 cm subpleural lung hamartoma deemed suitable for enucleation using coagulation of the underlying lung parenchyma with an argon laser; although immediate evaluation showed air-tight lung parenchyma, 24 hours later he developed a small air leak that eventually progressed and prevented full lung expansion. Thoracoscopy identified a moderate bronchopleural fistula at the previous enucleation site, which was endoscopically sutured; no further problem was encountered (this was the only patient managed by enucleation instead of stapled lung resection). Late morbidity was present in three patients who developed persistent intercostal pain that required analgesics for an average of 2 months postoperatively. Approximately 80% of these patients (60/71) had increased referred thoracic pain at the surgical portals about 5 to 7 days after the procedure; this "late thoracoscopy-port pain syndrome" seems to be related to an increase in swelling of the surgical incisions during the latter part of the inflammatory phase and tends to disappear within 5 to 10 days. It is rare that this syndrome requires analgesia other than NSAIDs.

Histologic diagnosis revealed a benign inflammatory cause in 65 nodules (granulomas 74%, other 6%), and neoplasia was diagnosed in 16 of the resected nodules (20%) (Table 5). There were nine cases of primary lung neoplasia, with three related to metastatic disease, and four benign tumors. Four patients presented with non-small-cell lung cancer, three of whom were further treated with lobectomy and lymph node dissection corresponding to stage 1a lung cancer. The fourth patient had supraclavicular metastasis of a squamous cell carcinoma originating in a small 17 mm apical nodule.

As mentioned above, six patients had more than one nodule resected at the same operation. One patient was diagnosed with metastatic spread of a known primary renal tumor that had been previously resected. The remaining were diagnosed with benign granulomatous disease. Worthy of mention is the case of a 46-year-old woman with a history of a previously resected breast carcinoma; 18 months after the mastectomy two nodular lesions were detected in the right lung, both of which had not been present on previous CT scans (Fig. 1). Thoracoscopy was performed for suspected metastatic disease. Both lesions were resected as was a third nodule not seen in the CT scan. All three nodules were diagnosed as nonspecific granulomas.

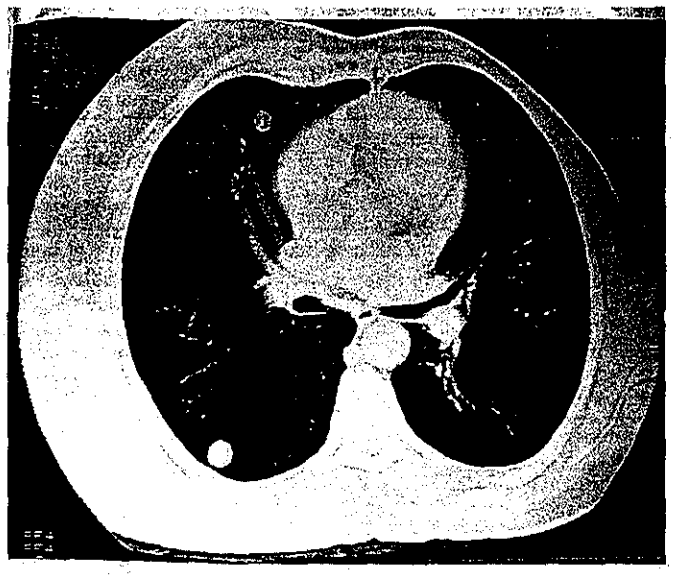

Fig. 1. Thoracic computed tomography (CT) scan of a 53-year-old woman on follow-up 2 years after a left mastectomy for ductal carcinoma. Two previously undetected lung nodules can be seen in the right lung. With the suspicion of metastatic disease a right thoracoscopic wedge resection was planned. After thorough thoracoscopic examination of the right chest cavity a third nodule was detected. All three nodules were managed with nonanatomic wedge resection using an endoscopic automatic stapling device. Histopathology proved them to be noncaseating granulomatous lesions.

Discussion

Thoracoscopy has evolved dramatically since Jacobaeus' first description in 1910 [6]. The introduction of video technology has widened the indications for thoracoscopy, which have been increasing constantly; most authors now consider this approach as ideal for lung wedge resection of diffuse pulmonary disease and indeterminate pulmonary nodules [7–9]. In fact, in our group of patients these disorders constituted the first two indications for video-thoracoscopy (Table 1).

The evaluation of patients who present with dyspnea and pulmonary infiltrates includes such methods as sputum analysis, bronchoscopy with bronchoalveolar lavage, and transbronchial biopsy, all of which frequently provide a diagnosis. When these methods fail to establish a definitive diagnosis, surgical open wedge lung biopsy is indicated with a diagnostic yield of more than 90% [10], which is much higher than that of other routinely used methods [11]. The impact of the lung biopsy result is difficult to assess. Most agree on the importance of obtaining information that changes the therapeutic regimen established for the patient; however, the impact on patient survival seems to be significant. Despite finding an unexpected diagnosis and changing the treatment, survival is not altered [12–14].

Thoracoscopy permits a suitable affected lung region to be selected for resectional wedge biopsy, and a thorough examination of the pleural cavity is performed. Three of our patients presented with undetected pleural metastasis, and one of them required a pleuropericardial window for pericardial effusion during the same thoracoscopic procedure. This is an advantage over the open lung biopsy technique in which the lung tissue obtained depends on the thoracotomy site, and thoracic evaluation is not feasible. Although comparison of open versus thoracoscopic techniques is not the purpose of this study, our experience is similar to that reported by others regarding mortality and morbidity as well as the success of establishing a pathologic diagnosis [15–17]. Interestingly, all postoperative air leaks in our group of patients appeared only in those who underwent mechanical ventilation, whereas none appeared in the nonventilated group. This situation relates to the risk imposed by high airway pressure in patients with severely impaired pulmonary function who frequently suffer from other acute medical conditions.

The mean operating time for this group was 47 ± 16 minutes. Follow-up has been 54 ± 5 months. Pleural drainage was required during mean of 1.7 days (range 0–5 days), and the last 20 cases have been managed without chest drainage. Postoperative analgesia was established with opiates for 1 day and NSAIDs for a mean of 3.8 ± 2 days.

Early and late morbidity was observed in this group of patients. Early morbidity was present in only one patient, who developed a persistent air leak that required resuturing. This patient presented with a 1 cm subpleural lung hamartoma deemed suitable for enucleation using coagulation of the underlying lung parenchyma with an argon laser; although immediate evaluation showed air-tight lung parenchyma, 24 hours later he developed a small air leak that eventually progressed and prevented full lung expansion. Thoracoscopy identified a moderate bronchopleural fistula at the previous enucleation site, which was endoscopically sutured; no further problem was encountered (this was the only patient managed by enucleation instead of stapled lung resection). Late morbidity was present in three patients who developed persistent intercostal pain that required analgesics for an average of 2 months postoperatively. Approximately 80% of these patients (60/71) had increased referred thoracic pain at the surgical portals about 5 to 7 days after the procedure; this "late thoracoscopy-port pain syndrome" seems to be related to an increase in swelling of the surgical incisions during the latter part of the inflammatory phase and tends to disappear within 5 to 10 days. It is rare that this syndrome requires analgesia other than NSAIDs.

Histologic diagnosis revealed a benign inflammatory cause in 65 nodules (granulomas 74%, other 6%), and neoplasia was diagnosed in 16 of the resected nodules (20%) (Table 5). There were nine cases of primary lung neoplasia, with three related to metastatic disease, and four benign tumors. Four patients presented with non-small-cell lung cancer, three of whom were further treated with lobectomy and lymph node dissection corresponding to stage 1a lung cancer. The fourth patient had supraclavicular metastasis of a squamous cell carcinoma originating in a small 17 mm apical nodule.

As mentioned above, six patients had more than one nodule resected at the same operation. One patient was diagnosed with metastatic spread of a known primary renal tumor that had been previously resected. The remaining were diagnosed with benign granulomatous disease. Worthy of mention is the case of a 46-year-old woman with a history of a previously resected breast carcinoma; 18 months after the mastectomy two nodular lesions were detected in the right lung, both of which had not been present on previous CT scans (Fig. 1). Thoracoscopy was performed for suspected metastatic disease. Both lesions were resected as was a third nodule not seen in the CT scan. All three nodules were diagnosed as nonspecific granulomas.

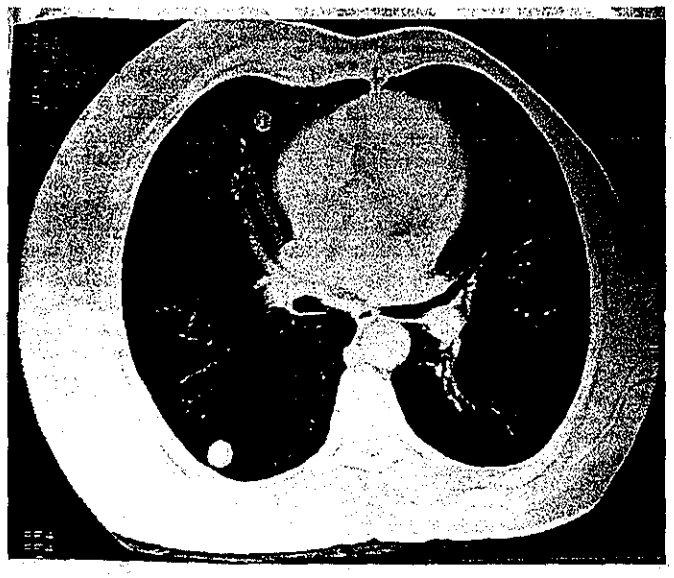

Fig. 1. Thoracic computed tomography (CT) scan of a 53-year-old woman on follow-up 2 years after a left mastectomy for ductal carcinoma. Two previously undetected lung nodules can be seen in the right lung. With the suspicion of metastatic disease a right thoracoscopic wedge resection was planned. After thorough thoracoscopic examination of the right chest cavity a third nodule was detected. All three nodules were managed with nonanatomic wedge resection using an endoscopic automatic stapling device. Histopathology proved them to be noncaseating granulomatous lesions.

Discussion

Thoracoscopy has evolved dramatically since Jacobaeus' first description in 1910 [6]. The introduction of video technology has widened the indications for thoracoscopy, which have been increasing constantly; most authors now consider this approach as ideal for lung wedge resection of diffuse pulmonary disease and indeterminate pulmonary nodules [7–9]. In fact, in our group of patients these disorders constituted the first two indications for video-thoracoscopy (Table 1).

The evaluation of patients who present with dyspnea and pulmonary infiltrates includes such methods as sputum analysis, bronchoscopy with bronchoalveolar lavage, and transbronchial biopsy, all of which frequently provide a diagnosis. When these methods fail to establish a definitive diagnosis, surgical open wedge lung biopsy is indicated with a diagnostic yield of more than 90% [10], which is much higher than that of other routinely used methods [11]. The impact of the lung biopsy result is difficult to assess. Most agree on the importance of obtaining information that changes the therapeutic regimen established for the patient; however, the impact on patient survival seems to be significant. Despite finding an unexpected diagnosis and changing the treatment, survival is not altered [12–14].

Thoracoscopy permits a suitable affected lung region to be selected for resectional wedge biopsy, and a thorough examination of the pleural cavity is performed. Three of our patients presented with undetected pleural metastasis, and one of them required a pleuropericardial window for pericardial effusion during the same thoracoscopic procedure. This is an advantage over the open lung biopsy technique in which the lung tissue obtained depends on the thoracotomy site, and thoracic evaluation is not feasible. Although comparison of open versus thoracoscopic techniques is not the purpose of this study, our experience is similar to that reported by others regarding mortality and morbidity as well as the success of establishing a pathologic diagnosis [15–17]. Interestingly, all postoperative air leaks in our group of patients appeared only in those who underwent mechanical ventilation, whereas none appeared in the nonventilated group. This situation relates to the risk imposed by high airway pressure in patients with severely impaired pulmonary function who frequently suffer from other acute medical conditions.

Pulmonary wedge resection for indeterminate lung nodules was the most frequently performed procedure, and a total of 81 nodules were resected from 71 patients. The main concern regarding a lung nodule is the possibility of malignancy. Despite analysis of clinical and radiologic characteristics, the certainty regarding the probability of a nodule being malignant is low. Many reports have dealt with probabilistic methods such as receiving operating characteristic analysis, logistic models, and Bayesian analysis in an attempt to refine decision-making in the management of these patients [18–21]. The bottom line is whether a nodule should be simply observed (opening the possibility of maintaining a possible primary lung cancer) or to submit the patient to thoracotomy and resection. Midway alternatives, such as fine-needle transthoracic or transbronchial aspiration, have shown a reasonable positive predictive value for malignancy. However, we share the view that because a negative result cannot exclude a malignancy (therefore maintaining diagnostic doubt) and a positive malignant result eventually requires surgical resection, the option of immediate surgical resection through a minimally invasive approach is appealing.

Among the group of patients submitted to lung nodule resection, mortality was null with almost negligible morbidity related to the procedure. This is in accord with other published results [8, 9]. The issue of whether surgical resection positively affects the survival of patients in whom lung cancer was encountered goes beyond the scope of the present study. One must consider a "reverse effect," such as that encountered when a benign diagnosis eliminates a high suspicion of malignancy (Fig. 1).

The postoperative course of all patients submitted to nodule resection was excellent. The duration of pleural drainage has been gradually reduced and even eliminated in selected cases (see Materials and Methods). The avoidance of pleural drainage opens the possibility of further shortening the hospital stay to 1 day. Others have offered similar ideas [8, 22], but we believe it is the medical condition of the patient regarding the primary diagnosis that should dictate the need of hospital care and not necessarily the procedure performed.

Pain control is much easier, though not totally eliminated. In fact, a curious "late thoracoscopy-port pain syndrome" presents in which pain seems to increase about 5 to 7 days after resection probably due to portal tract cicatricial inflammation. This syndrome tends to subside during the next 2 weeks and usually responds well to NSAIDs.

Although lung nodule localization has been an issue considered in several publications [23, 24], it has been our experience that thorough evaluation of preoperative imaging studies, a well deflated lung, and instrumental palpation permit adequate localization of all nodules. In fact, among our patients the need for digital palpation was required only twice (once for a small 8 mm carcinoid tumor and on a second occasion in a patient with rounded atelectasis that had subsided by the time thoracoscopy was performed).

Most series on lung nodule resection account for a malignant final diagnosis in the 30% to 40% range [8–24]. We found a neoplasic diagnosis for 20% of the resected nodules, with a rather large presence of granulomatous lesions. It is probable that local epidemiologic factors influence this finding. Other series from Mexico have reported a high incidence of granulomatous lesions in an oncologic center setting [25], findings that are consistent with our initial experience [26].

The aim of the present study was to focus on diffuse lung disease and the indeterminate pulmonary nodule; however, lung resection in patients with pneumothorax due to localized bullous disease requires special mention. In our series, 11 patients with pneumothorax were submitted to thoracoscopy. Seven of these patients had thoracoscopic nonanatomic lung resection of affected parenchyma with concomitant pleural abrasion or apical pleurectomy. The remaining patient had an air leak after lung nodule enucleation (described above). The small number of patients treated for pneumothorax is a result of the referral pattern at our institution. Others have proved the value of thoracoscopy in the management of spontaneous pneumothorax [27, 28].

Conclusions

Lung resection for diffuse pulmonary disease and an indeterminate nodule is feasible using minimally invasive methods (thoracoscopic nonanatomic lung wedge resection). The morbidity and mortality for lung resection in patients with diffuse disease is related to the underlying disease and the respiratory status of the patients (patients requiring mechanical ventilation are at risk of an air leak and bronchopleural fistula). We believe that management of an indeterminate lung nodule should strongly consider thoracoscopic resection unless a reasonable probability of a benign lesion can be attained through analysis of clinicoradiologic characteristics (i.e., calcification, long-standing presence of the disease).

Résumé. La vidéotechnologie a révolutionné de façon dramatique la thoracoscopie, augmentant considérablement ses indications. On a revu les dossiers cliniques des patients ayant eu une vidéothoracoscopie pendant une période de 6 ans. Les critères d'inclusion ont été tout patient ayant eu une résection non anatomique, « en coin », du poumon pour maladie diffuse ou pour nodule de nature indéterminée. On a analysé l'évolution à court et à long terme. Au total, on a revu les dossiers concernant 310 procédés thoracoscopiques chez 250 patients. Parmi ces cas, 60 avaient une maladie pulmonaire diffuse et 71, un nodule de nature indéterminée. La morbidité globale des patients ayant une maladie diffuse a été de 5% (une hémorragie intercostale et deux fuites aériques). La mortalité globale a été de 11%, en rapport avec l'état respiratoire antérieur et la co-morbidité. 23% des patients qui n'avaient pas eu besoin de support ventilatoire mécanique préopératoire en ont eu besoin en postopératoire (taux de changement = 23%). La morbidité et la mortalité étaient nulles chez les patients qui n'avaient pas eu besoin de ventilation mécanique. L'indexe d'impacte thérapeutique (défini comme le nombre total de patients divisé par le nombre de patients pour lesquels l'initialisation ou l'arrêt du traitement spécifique a été le résultat d'une biopsie) pour la maladie pulmonaire diffuse a été de 0.9. En ce qui concerne la résection des nodules, la morbidité a été réduite à un patient qui a eu une fuite aérique persistante. Trois patients ont accusé une morbidité tardive sous forme de douleur intercostale persistante. La morbidité globale a été de 5.6%; la mortalité, nulle. La résection non anatomique, en coin, par vidéothoracoscopie est faisable pour les maladies pulmonaires diffuses et les nodules de nature indéterminée. La morbidité et la mortalité sont plus en rapport avec les maladies sous-jacentes et l'état pulmonaire antérieur qu'avec le procédé réalisé.

Resumen. La vídeo-tecnología ha revolucionado dramáticamente el campo de la toracoscopia, incrementando considerablemente sus indicaciones. Se efectúa un estudio retrospectivo de todas las historias clínicas de pacientes sometidos a vídeo-toracoscopia durante 6 años. El criterio de inclusión fue que al paciente se le hubiera realizado una resección pulmonar en cuña, por padecer una enfermedad difusa o un nódulo pulmonar indeterminado. Se analizaron los resultados precoces y tardíos. Se revisaron 310 procedimientos toracoscópicos realizados a 250 pacientes. De estos, 60 padecían una enfermedad pulmonar difusa y 71

Pulmonary wedge resection for indeterminate lung nodules was the most frequently performed procedure, and a total of 81 nodules were resected from 71 patients. The main concern regarding a lung nodule is the possibility of malignancy. Despite analysis of clinical and radiologic characteristics, the certainty regarding the probability of a nodule being malignant is low. Many reports have dealt with probabilistic methods such as receiving operating characteristic analysis, logistic models, and Bayesian analysis in an attempt to refine decision-making in the management of these patients [18–21]. The bottom line is whether a nodule should be simply observed (opening the possibility of maintaining a possible primary lung cancer) or to submit the patient to thoracotomy and resection. Midway alternatives, such as fine-needle transthoracic or transbronchial aspiration, have shown a reasonable positive predictive value for malignancy. However, we share the view that because a negative result cannot exclude a malignancy (therefore maintaining diagnostic doubt) and a positive malignant result eventually requires surgical resection, the option of immediate surgical resection through a minimally invasive approach is appealing.

Among the group of patients submitted to lung nodule resection, mortality was null with almost negligible morbidity related to the procedure. This is in accord with other published results [8, 9]. The issue of whether surgical resection positively affects the survival of patients in whom lung cancer was encountered goes beyond the scope of the present study. One must consider a "reverse effect," such as that encountered when a benign diagnosis eliminates a high suspicion of malignancy (Fig. 1).

The postoperative course of all patients submitted to nodule resection was excellent. The duration of pleural drainage has been gradually reduced and even eliminated in selected cases (see Materials and Methods). The avoidance of pleural drainage opens the possibility of further shortening the hospital stay to 1 day. Others have offered similar ideas [8, 22], but we believe it is the medical condition of the patient regarding the primary diagnosis that should dictate the need of hospital care and not necessarily the procedure performed.

Pain control is much easier, though not totally eliminated. In fact, a curious "late thoracoscopy-port pain syndrome" presents in which pain seems to increase about 5 to 7 days after resection probably due to portal tract cicatricial inflammation. This syndrome tends to subside during the next 2 weeks and usually responds well to NSAIDs.

Although lung nodule localization has been an issue considered in several publications [23, 24], it has been our experience that thorough evaluation of preoperative imaging studies, a well deflated lung, and instrumental palpation permit adequate localization of all nodules. In fact, among our patients the need for digital palpation was required only twice (once for a small 8 mm carcinoid tumor and on a second occasion in a patient with rounded atelectasis that had subsided by the time thoracoscopy was performed).

Most series on lung nodule resection account for a malignant final diagnosis in the 30% to 40% range [8–24]. We found a neoplasic diagnosis for 20% of the resected nodules, with a rather large presence of granulomatous lesions. It is probable that local epidemiologic factors influence this finding. Other series from Mexico have reported a high incidence of granulomatous lesions in an oncologic center setting [25], findings that are consistent with our initial experience [26].

The aim of the present study was to focus on diffuse lung disease and the indeterminate pulmonary nodule; however, lung resection in patients with pneumothorax due to localized bullous disease requires special mention. In our series, 11 patients with pneumothorax were submitted to thoracoscopy. Seven of these patients had thoracoscopic nonanatomic lung resection of affected parenchyma with concomitant pleural abrasion or apical pleurectomy. The remaining patient had an air leak after lung nodule enucleation (described above). The small number of patients treated for pneumothorax is a result of the referral pattern at our institution. Others have proved the value of thoracoscopy in the management of spontaneous pneumothorax [27, 28].

Conclusions

Lung resection for diffuse pulmonary disease and an indeterminate nodule is feasible using minimally invasive methods (thoracoscopic nonanatomic lung wedge resection). The morbidity and mortality for lung resection in patients with diffuse disease is related to the underlying disease and the respiratory status of the patients (patients requiring mechanical ventilation are at risk of an air leak and bronchopleural fistula). We believe that management of an indeterminate lung nodule should strongly consider thoracoscopic resection unless a reasonable probability of a benign lesion can be attained through analysis of clinicoradiologic characteristics (i.e., calcification, long-standing presence of the disease).

Résumé. La vidéotechnologie a révolutionné de façon dramatique la thoracoscopie, augmentant considérablement ses indications. On a revu les dossiers cliniques des patients ayant eu une vidéothoracoscopie pendant une période de 6 ans. Les critères d'inclusion ont été tout patient ayant eu une résection non anatomique, « en coin », du poumon pour maladie diffuse ou pour nodule de nature indéterminée. On a analysé l'évolution à court et à long terme. Au total, on a revu les dossiers concernant 310 procédés thoracoscopiques chez 250 patients. Parmi ces cas, 60 avaient une maladie pulmonaire diffuse et 71, un nodule de nature indéterminée. La morbidité globale des patients ayant une maladie diffuse a été de 5% (une hémorragie intercostale et deux fuites aériques). La mortalité globale a été de 11%, en rapport avec l'état respiratoire antérieur et la co-morbidité. 23% des patients qui n'avaient pas eu besoin de support ventilatoire mécanique préopératoire en ont eu besoin en postopératoire (taux de changement = 23%). La morbidité et la mortalité étaient nulles chez les patients qui n'avaient pas eu besoin de ventilation mécanique. L'indexe d'impacte thérapeutique (défini comme le nombre total de patients divisé par le nombre de patients pour lesquels l'initialisation ou l'arrêt du traitement spécifique a été le résultat d'une biopsie) pour la maladie pulmonaire diffuse a été de 0.9. En ce qui concerne la résection des nodules, la morbidité a été réduite à un patient qui a eu une fuite aérique persistante. Trois patients ont accusé une morbidité tardive sous forme de douleur intercostale persistante. La morbidité globale a été de 5.6%; la mortalité, nulle. La résection non anatomique, en coin, par vidéothoracoscopie est faisable pour les maladies pulmonaires diffuses et les nodules de nature indéterminée. La morbidité et la mortalité sont plus en rapport avec les maladies sous-jacentes et l'état pulmonaire antérieur qu'avec le procédé réalisé.

Resumen. La vídeo-tecnología ha revolucionado dramáticamente el campo de la toracoscopia, incrementando considerablemente sus indicaciones. Se efectúa un estudio retrospectivo de todas las historias clínicas de pacientes sometidos a vídeo-toracoscopia durante 6 años. El criterio de inclusión fue que al paciente se le hubiera realizado una resección pulmonar en cuña, por padecer una enfermedad difusa o un nódulo pulmonar indeterminado. Se analizaron los resultados precoces y tardíos. Se revisaron 310 procedimientos toracoscópicos realizados a 250 pacientes. De estos, 60 padecían una enfermedad pulmonar difusa y 71

Pulmonary wedge resection for indeterminate lung nodules was the most frequently performed procedure, and a total of 81 nodules were resected from 71 patients. The main concern regarding a lung nodule is the possibility of malignancy. Despite analysis of clinical and radiologic characteristics, the certainty regarding the probability of a nodule being malignant is low. Many reports have dealt with probabilistic methods such as receiving operating characteristic analysis, logistic models, and Bayesian analysis in an attempt to refine decision-making in the management of these patients [18–21]. The bottom line is whether a nodule should be simply observed (opening the possibility of maintaining a possible primary lung cancer) or to submit the patient to thoracotomy and resection. Midway alternatives, such as fine-needle transthoracic or transbronchial aspiration, have shown a reasonable positive predictive value for malignancy. However, we share the view that because a negative result cannot exclude a malignancy (therefore maintaining diagnostic doubt) and a positive malignant result eventually requires surgical resection, the option of immediate surgical resection through a minimally invasive approach is appealing.

Among the group of patients submitted to lung nodule resection, mortality was null with almost negligible morbidity related to the procedure. This is in accord with other published results [8, 9]. The issue of whether surgical resection positively affects the survival of patients in whom lung cancer was encountered goes beyond the scope of the present study. One must consider a "reverse effect," such as that encountered when a benign diagnosis eliminates a high suspicion of malignancy (Fig. 1).

The postoperative course of all patients submitted to nodule resection was excellent. The duration of pleural drainage has been gradually reduced and even eliminated in selected cases (see Materials and Methods). The avoidance of pleural drainage opens the possibility of further shortening the hospital stay to 1 day. Others have offered similar ideas [8, 22], but we believe it is the medical condition of the patient regarding the primary diagnosis that should dictate the need of hospital care and not necessarily the procedure performed.

Pain control is much easier, though not totally eliminated. In fact, a curious "late thoracoscopy-port pain syndrome" presents in which pain seems to increase about 5 to 7 days after resection probably due to portal tract cicatricial inflammation. This syndrome tends to subside during the next 2 weeks and usually responds well to NSAIDs.

Although lung nodule localization has been an issue considered in several publications [23, 24], it has been our experience that thorough evaluation of preoperative imaging studies, a well deflated lung, and instrumental palpation permit adequate localization of all nodules. In fact, among our patients the need for digital palpation was required only twice (once for a small 8 mm carcinoid tumor and on a second occasion in a patient with rounded atelectasis that had subsided by the time thoracoscopy was performed).

Most series on lung nodule resection account for a malignant final diagnosis in the 30% to 40% range [8–24]. We found a neoplasic diagnosis for 20% of the resected nodules, with a rather large presence of granulomatous lesions. It is probable that local epidemiologic factors influence this finding. Other series from Mexico have reported a high incidence of granulomatous lesions in an oncologic center setting [25], findings that are consistent with our initial experience [26].

The aim of the present study was to focus on diffuse lung disease and the indeterminate pulmonary nodule; however, lung resection in patients with pneumothorax due to localized bullous disease requires special mention. In our series, 11 patients with pneumothorax were submitted to thoracoscopy. Seven of these patients had thoracoscopic nonanatomic lung resection of affected parenchyma with concomitant pleural abrasion or apical pleurectomy. The remaining patient had an air leak after lung nodule enucleation (described above). The small number of patients treated for pneumothorax is a result of the referral pattern at our institution. Others have proved the value of thoracoscopy in the management of spontaneous pneumothorax [27, 28].

Conclusions

Lung resection for diffuse pulmonary disease and an indeterminate nodule is feasible using minimally invasive methods (thoracoscopic nonanatomic lung wedge resection). The morbidity and mortality for lung resection in patients with diffuse disease is related to the underlying disease and the respiratory status of the patients (patients requiring mechanical ventilation are at risk of an air leak and bronchopleural fistula). We believe that management of an indeterminate lung nodule should strongly consider thoracoscopic resection unless a reasonable probability of a benign lesion can be attained through analysis of clinicoradiologic characteristics (i.e., calcification, long-standing presence of the disease).

Résumé. La vidéotechnologie a révolutionné de façon dramatique la thoracoscopie, augmentant considérablement ses indications. On a revu les dossiers cliniques des patients ayant eu une vidéothoracoscopie pendant une période de 6 ans. Les critères d'inclusion ont été tout patient ayant eu une résection non anatomique, « en coin », du poumon pour maladie diffuse ou pour nodule de nature indéterminée. On a analysé l'évolution à court et à long terme. Au total, on a revu les dossiers concernant 310 procédés thoracoscopiques chez 250 patients. Parmi ces cas, 60 avaient une maladie pulmonaire diffuse et 71, un nodule de nature indéterminée. La morbidité globale des patients ayant une maladie diffuse a été de 5% (une hémorragie intercostale et deux fuites aériques). La mortalité globale a été de 11%, en rapport avec l'état respiratoire antérieur et la co-morbidité. 23% des patients qui n'avaient pas eu besoin de support ventilatoire mécanique préopératoire en ont eu besoin en postopératoire (taux de changement = 23%). La morbidité et la mortalité étaient nulles chez les patients qui n'avaient pas eu besoin de ventilation mécanique. L'indexe d'impacte thérapeutique (défini comme le nombre total de patients divisé par le nombre de patients pour lesquels l'initialisation ou l'arrêt du traitement spécifique a été le résultat d'une biopsie) pour la maladie pulmonaire diffuse a été de 0.9. En ce qui concerne la résection des nodules, la morbidité a été réduite à un patient qui a eu une fuite aérique persistante. Trois patients ont accusé une morbidité tardive sous forme de douleur intercostale persistante. La morbidité globale a été de 5.6%; la mortalité, nulle. La résection non anatomique, en coin, par vidéothoracoscopie est faisable pour les maladies pulmonaires diffuses et les nodules de nature indéterminée. La morbidité et la mortalité sont plus en rapport avec les maladies sous-jacentes et l'état pulmonaire antérieur qu'avec le procédé réalisé.

Resumen. La vídeo-tecnología ha revolucionado dramáticamente el campo de la toracoscopia, incrementando considerablemente sus indicaciones. Se efectúa un estudio retrospectivo de todas las historias clínicas de pacientes sometidos a vídeo-toracoscopia durante 6 años. El criterio de inclusión fue que al paciente se le hubiera realizado una resección pulmonar en cuña, por padecer una enfermedad difusa o un nódulo pulmonar indeterminado. Se analizaron los resultados precoces y tardíos. Se revisaron 310 procedimientos toracoscópicos realizados a 250 pacientes. De estos, 60 padecían una enfermedad pulmonar difusa y 71

presentaban un nódulo pulmonar indeterminado. La morbilidad total, en aquellos que padecían una enfermedad difusa pulmonar, alcanzó al 5% (una hemorragia por lesión de una intercostal y 2 fugas aéreas). En este grupo la mortalidad total, que ha de referirse a la enfermedad subyacente y al estado respiratorio previo, fue del 11%. El 23% de pacientes que preoperatoriamente no necesitaban ventilación mecánica la requirieron en le periodo postoperatorio. En aquellos pacientes que no necesitaron ventilación mecánica alguna, la morbilidad y mortalidad fueron nulas. El índice de impacto terapéutico (definido como el cociente resultante de dividir el número total de pacientes, por el número de aquellos que tras los resultados de la biopsia requirieron iniciar o suspender un tratamiento específico) fue para la enfermedad pulmonar difusa del 0.9. Por lo que a la resección de nódulos pulmonares se refiere, morbilidad precoz se constató en un paciente, que desarrolló una fuga aérea persistente; morbilidad tardía se registró en 3 pacientes que desarrollaron dolor intercostal constante. La morbilidad total fue del 5.6%. En este grupo, la mortalidad fue nula. La vídeo-toracoscopia, una técnica mínimamente invasiva, permite efectuar resecciones pulmonares no anatómicas en cuña, en pacientes con enfermedad pulmonar difusa o con nódulos pulmonares indeterminados (sin diagnóstico preciso). La morbi-mortalidad ha de referirse más a la enfermedad subyacente y al estado de la función respiratoria, que al procedimiento quirúrgico empleado.

References

1. Fleishman SJ, Liother AI, Bouhanan G, Sichel RJS: Investigation of idiopatic pleural effusions by thoracoscopy. Thorax 1956;11:324
2. Lewis RJ, Kunderman PJ, Sisler GE, Mackenzie JW: Direct diagnostic thoracoscopy. Ann. Thorac. Surg. 1976;21:6
3. Baumgartner WA, Mark JBI: The use of thoracoscopy in the diagnosis of pleural disease. Arch. Surg. 1980;115:8
4. Landrenau RJ, Mack MJ, Hazelrigg SR, Dowling RD, Keenan RJJ, Ferson PF: *Thoracoscopic management of benign pulmonary lesions.* Chest Surg. Clin. N. Am. 1993;3:249
5. Lewis RJ, Sisler GE, Caccavale RJ: Imaged thoracic lobectomy: should it be done? Ann. Thorac. Surg. 1992;54:80
6. Jacobeaus HC: The cauterization of adhesions in pneumothorax treatment of tuberculosis. Surg. Gynecol. Obstet. 1921;32:493
7. Ferson PF, Landrenau RJ: Thoracoscopic lung biopsy or open lung biopsy for interstitial lung disease. Chest Surg. Clin. N. Am. 1998;8: 749
8. Hazelrigg SR, Magee MJ, Cetindag IB: Video-assisted thoracic surgery for diagnosis of the solitary lung nodule. Chest Surg. Clin. N. Am. 1998;8:763
9. Hazelrigg SR, Nunchuck SK, LoCicero J: Video-assisted thoracic surgery study group data. Ann. Thorac. Surg. 1993;56:1039
10. Gaensler ER, Carrington CB: Open biopsy for chronic diffuse infiltrative lung disease: clinical, roentgenographic and physiological correlations in 502 patients. Ann. Thorac. Surg. 1980;30:411
11. Wall CP, Gaensler EA, Carrington CB, Hayes JA: Comparison of transbronchial and open biopsies in chronic infiltrative lung disease. Am. Rev. Respir. Dis. 1981;123:230
12. Thomas JH, Farek PE, Hermreck AS, Pierce GE: Diagnostic value of open lung biopsy in immunocompromised patients. Am. J. Surg. 1987;154:692
13. Warner DO, Warner MA, Divertie MB: Open lung biopsy in patients with diffuse pulmonary infiltrates and acute respiratory failure. Am. Rev. Respir. Dis. 1988;37:90
14. Renault P, LePimpec-Bathes F, Chouaid C, Riquet M, Manach D, Housset B: Surgical pulmonary biopsies in patients with HIV infection. Rev. Med. Interne 1997;18:407
15. Ferson PF, Landrenau RJ, Dowling RD, Hazelrigg SR, Ritter P, Nunchuck S, Perrino MK, Bowers CM, Mack MJ, Magee MJ: Comparison of open versus thoracoscopic lung biopsy for diffuse infiltrative pulmonary disease. J. Thorac. Cardiovasc. Surg. 1993;106:194
16. Bentzon N, Adamsen S, Jacobsen B, Eriksen C, Hansen OH: Videothoracoscopic lung biopsy by a stapling technique. Eur. J. Surg. 1994; 160:5436
17. Krasna MJ, White CS, Aisner SC, Templeton PA, MacLaughlin JS: The role of thoracoscopy in the diagnosis of interstitial lung disease. Ann. Thorac. Surg. 1995;59:348
18. Swensen SJ, Silverstein MD, Eddell ES, Trastek VF, Aughenbaugh GL, Ilstrup DN, Schleck CD: Solitary pulmonary nodules: clinical prediction model versus physicians. Mayo Clin. Proc. 1999;74:319
19. Lillington GA: Management of solitary pulmonary nodules. Postgrad. Med. 1997;101:145
20. Gurney JW: Determining the likelihood of malignancy in solitary pulmonary nodules with Bayesian analysis. Part I. Theory. Radiology 1993;186:405
21. Gurney JW: Determining the likelihood of malignancy in solitary pulmonary nodules with Bayesian analysis. Part II. Aplication. Radiology 1993;186:415
22. Russo L, Weichmann RJ, Kaplan PD: The safety and efficacy of immediate chest tube removal following videoassisted wedge resection of the lung [poster]. Presented at the 34th annual meeting of the Society of Thoracic Surgeons. New Orleans, 1998
23. Templeton PA, Krasna M: Needle wire lung nodule localization for thoracoscopic resection. Chest 1993;104:953
24. Schwartz RE, Posner MC, Plunkett MB, Ferson PF, Keenan RJ, Landrenau RJ: Needle localized thoracoscopic resection (NLTR) of indeterminate pulmonary nodules: impact on management of patients with malignant disease. Ann. Surg. Oncol. 1995;2:49
25. Ibarra-Pérez C, Kelly-García J, Fuentes-Mattos R: Nódulo pulmonar solitario en el departamento de cirugía de tórax de un hospital oncológico. Rev. Inst. Natl. Enf. Respir. Mex. 1997;10:164
26. Santillán-Doherty P: Video-assisted surgery for management of thoracic problems. Rev. Invest. Clin. (Mex.) 1995;47:393
27. Mouroux J, Elkaïm D, Padovani B, Myx A, Perrin C, Rotomondo C, Chavaillon JM, Blaive B, Richelme H: Video-assisted thoracoscopic treatment of spontaneous pneumothorax: techniques and results of one-hundred cases. J. Thorac. Cardiovasc. Surg. 1996;112:385
28. Liu HP, Yim APC, Izzat MB, Lin PJ, Chang CH: Thoracoscopic surgery for spontaneous pneumothorax. World J. Surg. 1999;23:1133

presentaban un nódulo pulmonar indeterminado. La morbilidad total, en aquellos que padecían una enfermedad difusa pulmonar, alcanzó al 5% (una hemorragia por lesión de una intercostal y 2 fugas aéreas). En este grupo la mortalidad total, que ha de referirse a la enfermedad subyacente y al estado respiratorio previo, fue del 11%. El 23% de pacientes que preoperatoriamente no necesitaban ventilación mecánica la requirieron en le periodo postoperatorio. En aquellos pacientes que no necesitaron ventilación mecánica alguna, la morbilidad y mortalidad fueron nulas. El índice de impacto terapéutico (definido como el cociente resultante de dividir el número total de pacientes, por el número de aquellos que tras los resultados de la biopsia requirieron iniciar o suspender un tratamiento específico) fue para la enfermedad pulmonar difusa del 0.9. Por lo que a la resección de nódulos pulmonares se refiere, morbilidad precoz se constató en un paciente, que desarrolló una fuga aérea persistente; morbilidad tardía se registró en 3 pacientes que desarrollaron dolor intercostal constante. La morbilidad total fue del 5.6%. En este grupo, la mortalidad fue nula. La vídeo-toracoscopia, una técnica mínimamente invasiva, permite efectuar resecciones pulmonares no anatómicas en cuña, en pacientes con enfermedad pulmonar difusa o con nódulos pulmonares indeterminados (sin diagnóstico preciso). La morbi-mortalidad ha de referirse más a la enfermedad subyacente y al estado de la función respiratoria, que al procedimiento quirúrgico empleado.

References

1. Fleishman SJ, Liother AI, Bouhanan G, Sichel RJS: Investigation of idiopatic pleural effusions by thoracoscopy. Thorax 1956;11:324
2. Lewis RJ, Kunderman PJ, Sisler GE, Mackenzie JW: Direct diagnostic thoracoscopy. Ann. Thorac. Surg. 1976;21:6
3. Baumgartner WA, Mark JBI: The use of thoracoscopy in the diagnosis of pleural disease. Arch. Surg. 1980;115:8
4. Landrenau RJ, Mack MJ, Hazelrigg SR, Dowling RD, Keenan RJJ, Ferson PF: *Thoracoscopic management of benign pulmonary lesions.* Chest Surg. Clin. N. Am. 1993;3:249
5. Lewis RJ, Sisler GE, Caccavale RJ: Imaged thoracic lobectomy: should it be done? Ann. Thorac. Surg. 1992;54:80
6. Jacobeaus HC: The cauterization of adhesions in pneumothorax treatment of tuberculosis. Surg. Gynecol. Obstet. 1921;32:493
7. Ferson PF, Landrenau RJ: Thoracoscopic lung biopsy or open lung biopsy for interstitial lung disease. Chest Surg. Clin. N. Am. 1998;8: 749
8. Hazelrigg SR, Magee MJ, Cetindag IB: Video-assisted thoracic surgery for diagnosis of the solitary lung nodule. Chest Surg. Clin. N. Am. 1998;8:763
9. Hazelrigg SR, Nunchuck SK, LoCicero J: Video-assisted thoracic surgery study group data. Ann. Thorac. Surg. 1993;56:1039
10. Gaensler ER, Carrington CB: Open biopsy for chronic diffuse infiltrative lung disease: clinical, roentgenographic and physiological correlations in 502 patients. Ann. Thorac. Surg. 1980;30:411
11. Wall CP, Gaensler EA, Carrington CB, Hayes JA: Comparison of transbronchial and open biopsies in chronic infiltrative lung disease. Am. Rev. Respir. Dis. 1981;123:230
12. Thomas JH, Farek PE, Hermreck AS, Pierce GE: Diagnostic value of open lung biopsy in immunocompromised patients. Am. J. Surg. 1987;154:692
13. Warner DO, Warner MA, Divertie MB: Open lung biopsy in patients with diffuse pulmonary infiltrates and acute respiratory failure. Am. Rev. Respir. Dis. 1988;37:90
14. Renault P, LePimpec-Bathes F, Chouaid C, Riquet M, Manach D, Housset B: Surgical pulmonary biopsies in patients with HIV infection. Rev. Med. Interne 1997;18:407
15. Ferson PF, Landrenau RJ, Dowling RD, Hazelrigg SR, Ritter P, Nunchuck S, Perrino MK, Bowers CM, Mack MJ, Magee MJ: Comparison of open versus thoracoscopic lung biopsy for diffuse infiltrative pulmonary disease. J. Thorac. Cardiovasc. Surg. 1993;106:194
16. Bentzon N, Adamsen S, Jacobsen B, Eriksen C, Hansen OH: Videothoracoscopic lung biopsy by a stapling technique. Eur. J. Surg. 1994; 160:5436
17. Krasna MJ, White CS, Aisner SC, Templeton PA, MacLaughlin JS: The role of thoracoscopy in the diagnosis of interstitial lung disease. Ann. Thorac. Surg. 1995;59:348
18. Swensen SJ, Silverstein MD, Eddell ES, Trastek VF, Aughenbaugh GL, Ilstrup DN, Schleck CD: Solitary pulmonary nodules: clinical prediction model versus physicians. Mayo Clin. Proc. 1999;74:319
19. Lillington GA: Management of solitary pulmonary nodules. Postgrad. Med. 1997;101:145
20. Gurney JW: Determining the likelihood of malignancy in solitary pulmonary nodules with Bayesian analysis. Part I. Theory. Radiology 1993;186:405
21. Gurney JW: Determining the likelihood of malignancy in solitary pulmonary nodules with Bayesian analysis. Part II. Aplication. Radiology 1993;186:415
22. Russo L, Weichmann RJ, Kaplan PD: The safety and efficacy of immediate chest tube removal following videoassisted wedge resection of the lung [poster]. Presented at the 34th annual meeting of the Society of Thoracic Surgeons. New Orleans, 1998
23. Templeton PA, Krasna M: Needle wire lung nodule localization for thoracoscopic resection. Chest 1993;104:953
24. Schwartz RE, Posner MC, Plunkett MB, Ferson PF, Keenan RJ, Landrenau RJ: Needle localized thoracoscopic resection (NLTR) of indeterminate pulmonary nodules: impact on management of patients with malignant disease. Ann. Surg. Oncol. 1995;2:49
25. Ibarra-Pérez C, Kelly-García J, Fuentes-Mattos R: Nódulo pulmonar solitario en el departamento de cirugía de tórax de un hospital oncológico. Rev. Inst. Natl. Enf. Respir. Mex. 1997;10:164
26. Santillán-Doherty P: Video-assisted surgery for management of thoracic problems. Rev. Invest. Clin. (Mex.) 1995;47:393
27. Mouroux J, Elkaïm D, Padovani B, Myx A, Perrin C, Rotomondo C, Chavaillon JM, Blaive B, Richelme H: Video-assisted thoracoscopic treatment of spontaneous pneumothorax: techniques and results of one-hundred cases. J. Thorac. Cardiovasc. Surg. 1996;112:385
28. Liu HP, Yim APC, Izzat MB, Lin PJ, Chang CH: Thoracoscopic surgery for spontaneous pneumothorax. World J. Surg. 1999;23:1133