



## minimally invasive techniques

### Videothoracoscopic Approach to Primary Mediastinal Pathology\*

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**Study objectives:** Personal results and validity of videothoracoscopic (VTS) approach to primary mediastinal diseases are analyzed.

**Design:** Retrospective review of personal experience.

**Setting:** Department of Surgery, San Giuseppe Hospital, University of Milano, Italy.

**Patients:** From September 1991 to January 1999, of a personal series of 1,653 VTS procedures, 118 regarded primary mediastinal diseases. In 47 cases, diagnostic videothoracoscopy was performed to obtain large biopsy specimens or to carry out accurate staging; in 71 cases, full resection was anticipated.

**Interventions:** The patient, intubated with a double-lumen Carlen's tube and in the lateral decubitus position, underwent videothoracoscopy. Two ports and a small anterior *utility thoracotomy* were completed. Thorough exploration of the mediastinum and, if possible, complete resection of the lesion were accomplished.

**Measurements and results:** Videothoracoscopy yielded adequate diagnosis or staging in all patients operated on for diagnostic purposes. Of 71 patients operated on with resective intent, 66 had complete thoracoscopic resection (22 stage-I thymomas, 4 thymic cysts, 21 myasthenia gravis associated with thymic hyperplasia, 19 miscellaneous tumors). Conversion was required in five cases, mostly for invasion of mediastinal structures. Complications included the following: one patient developed intraoperative bleeding controlled endoscopically, two patients experienced postoperative bleeding requiring re-thoracoscopy, and one patient had postoperative pneumonia requiring assisted ventilation. One recurrence of malignant thymoma occurred 4 years postoperatively.

**Conclusions:** Videothoracoscopy can attain a leading role in obtaining large samples in lymphatic mediastinal diseases. Dysembriomas, schwannomas, simple cysts, and similar lesions can benefit from VTS removal. Total thymectomy for myasthenia gravis associated with thymic hyperplasia can be performed thoracoscopically. Further data and more extensive experience are needed.

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**Key words:** mediastinal neoplasms; myasthenia gravis; thoracoscopy; thymectomy; thymoma

Vide-assisted thoracoscopic surgery now represents a new and useful approach in the management of mediastinal disease.<sup>1-4</sup>

While thoracoscopy in many centers is now considered the approach of choice for treating certain kinds of thoracic diseases such as pneumothorax, giant pulmonary bullae, or peripheral pulmonary

lesions, mediastinal lesions are rarely approached through thoracoscopy.<sup>5-8</sup> The value of thoracoscopy is evident in cases of both diagnosis and treatment of mediastinal lesions.

Conventional diagnostic techniques are often unable to ensure a precise staging of the lesion. On the contrary, the videothoracoscopic approach can achieve a highly accurate degree of staging, and large endoscopic biopsies can also easily be obtained. Videothoracoscopic-assisted thoracic surgery can detect tumor invasion or metastatic spread that has gone unnoticed with other staging procedures, such as CT, and allows for evaluation of the feasibility of

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direct thoracoscopic removal in cases of well-encapsulated tumors. Selective and large biopsy specimens can be obtained thoracoscopically in case of nonencapsulated masses invading the nearby organs, thereby allowing the best choice of approach between thoracotomy and sternotomy.<sup>1,2,8,9</sup>

## MATERIALS AND METHODS

### Patients

From May 1991 to January 1999, of 1,653 videothoroscopic procedures, 118 regarded primary mediastinal lesions (Table 1). These do not include esophageal disease or metastatic mediastinal lymphadenopathy from lung cancer or from other primary neoplasms.

In 47 patients, the procedure was performed for diagnostic purposes. In 36 patients, the purpose was to obtain large and multiple biopsy specimens of suspected lymphoma. In three patients, thoracoscopy was aimed at staging malignant thymomas; thoracoscopy revealed an unsuspected malignant pleural invasion in one patient with a small thymoma that had been preoperatively assessed at stage I, while a massive mediastinal invasion was discovered in the other two cases. In all these cases, the operation was therefore discontinued after having obtained multiple biopsies of the lesions. In two other cases, a videothoroscopic biopsy revealed an unresectable malignant schwannoma and a liposarcoma. In the six remaining cases, a CT scan had revealed the presence of abnormal tissue within the thymic region following chemotherapy for chronic lymphocytic leukemia in two patients and for Hodgkin's disease in four patients. Thoracoscopy was therefore undertaken and demonstrated the presence of a thymic

lesion; a complete thymectomy was then achieved thoracoscopically. Histology of the specimen confirmed the persistence of the previous disease.

Thoracoscopy with a fully resective intent was performed in 71 patients.

In 66 patients, the procedure was completed thoracoscopically. Most of these resections were carried out for thymic disease (47 patients), which included 4 thymic cysts, 22 stage-I thymomas, and 21 cases of hyperplastic thymus in patients affected by myasthenia gravis. Of these last 21 patients, in one patient, a thymoma was discovered within the hyperplastic thymus. All patients affected by thymic hyperplasia were submitted to total thymectomy—in the first 4 patients through a left thoracoscopic approach, and in the next 17 patients through a bilateral thoracoscopic approach, which also allowed removing the fatty areolar pericardial tissue.

Thoracoscopic removal of other mediastinal tumors was carried out in 19 patients, and included five neurogenic tumors, three dysembryomas, two lipomas, three bronchogenic cysts, three pleuropericardial cysts, two enterogenous cysts, and one fibrous tumor in a patient that had been treated for Hodgkin's disease 10 years beforehand.

Conversion to thoracotomy was required in five cases: in one patient due to the considerable size and firm adhesions of a thymic cyst; in two patients due to large infiltrating and easily bleeding schwannomas; in another patient a large liposarcoma infiltrated the esophagus and the left main bronchus. In the last patient, suffering from myasthenia gravis with a hyperplastic and calcified thymus, firm adhesions to neighboring structures required conversion. Postoperative histology revealed the presence of a stage-I thymoma

### Operative Procedure

As this procedure has already been described in several of our previous reports, we will limit ourselves to a brief description.<sup>1-3,10</sup> The patient is intubated with a double-lumen Carlen's tube that allows *one-lung ventilation*, and subsequent collapse of the chosen lung. The patient is then placed in the lateral decubitus position, as for a conventional thoracotomy. A pillow is placed under the chest at the inferior scapular angle, and the operating table is slanted downwards on both sides from the center to ensure maximal stretching of the intercostal spaces and lowering of patient's pelvis. This will avoid hindering lateral or vertical movements of the camera.

Two monitors are placed on either side of the patient's head in order to provide the best view to all members of the operating team. The position of the surgical team and scrub nurse may change as required. All of the surgical instruments needed for an emergency thoracotomy must be ready in the theater.

The first 10-mm trocar for the camera is introduced along the mid-axillary line between the sixth and eighth intercostal spaces according to the site of the tumor.

After having explored the thoracic cavity and localized the tumor, two or rarely three other operative ports are positioned along the anterior and posterior axillary line between the fourth and sixth intercostal spaces to provide the best management of the lesion. A small, 4- to 6-cm incision (a utility thoracotomy) is performed between the anterior axillary line and the sternum, in the same fourth or fifth intercostal space that would eventually be used for a thoracotomy, should conversion be required.<sup>10</sup> This small incision is performed anteriorly because the intercostal spaces are wider and there are no large muscles to incise, except for the intercostals and a few fibers of the serratus anterior. The rib spreader is used only at the end of the operation in case of a large specimen in order to reduce the risk of damaging the intercostal nerve and subsequent postoperative pain. Further-

**Table 1—Breakdown of 118 Videothoroscopic Procedures for Primary Mediastinal Tumors**

Diagnostic procedures (n = 47)
36 lymphoma
3 malignant thymoma
1 liposarcoma
1 malignant schwannoma
2 chronic lymphocytic leukemia
4 Hodgkin's disease
Therapeutic procedures (n = 71)
Thoracoscopic resection (n = 66)
47 thymic disease
4 cyst
22 stage I thymoma
21 myasthenia gravis associated with thymic hyperplasia
5 neurogenic tumor
3 dysembryoma
2 lipoma
3 bronchogenic cyst
3 pleuropericardial cyst
2 enterogenous cyst
1 fibrous tumor
Conversion (n = 5)
2 infiltrating schwannoma
1 infiltrating liposarcoma
1 infiltrating thymoma
1 large adherent thymic cyst

more, in female patients, skin incision is performed along the inframammary fold in order to obtain a better cosmetic result.

Besides permitting extraction of the specimen, the utility thoracotomy allows inserting instruments that are not yet available in a thorascopic version and is also a useful emergency access in case of accidents during thorascopic procedures.

The specimen is usually placed in a plastic bag before the extraction in order to avoid tumor seeding.

If the patient must undergo a bilateral thorascopy, the procedure described above is repeated on the opposite side once the patient has been turned in the contralateral decubitus position.

Videothorascopic removal of a mediastinal mass follows the same steps and general rules as a conventional open mediastinal intervention, but tactics can vary depending on the site of the mass, which is usually constant for each kind of mediastinal tumor.

## RESULTS

The average operating time depends on the procedure, whether diagnostic or therapeutic. Adhesions, prior surgical interventions, or neoadjuvant chemotherapy treatment can individually influence the length of each procedure. For diagnostic purposes, large specimens can usually be acquired without particular difficulties, and the procedure from insertion of the first port to closure of the wound is relatively brief (range, 20 to 70 min). Removal can be more complex and also depends on the time needed to isolate the neighboring structures and on the accurate control of the hemostasis. In our series, the average operating time for a therapeutic procedure was 75 min (range, 25 to 180 min). This includes the prolonged operating times that marked the beginning of our experience; as our experience increased, the average operating times decreased.

The slight postoperative pain was controlled with common minor analgesics (nonsteroid, anti-inflammatory drugs) that were administered for not > 2 days.

The average postoperative hospital stay was 6 days (range, 2 to 60 days).

Most patients recovered swiftly and were discharged correspondingly. The postoperative hospital stay was extended in few patients more for social reasons than for clinical problems, as our health system guarantees free hospitalization, but many patients cannot benefit from a satisfactory home care.

Only one patient had intraoperative complications. A benign neurofibroma had been diagnosed on the basis of a preoperative fine-needle aspiration, and videothorascopic removal of the mass was carried out. During the procedure, diffuse bleeding had occurred, requiring one unit of blood transfusion. Postoperative histology revealed a malignant schwannoma. The patient was therefore submitted

to radiotherapy, but succumbed 11 months later due to pulmonary metastases and pleural diffusion.

Major postoperative complications occurred in three patients. Two patients, who underwent resection for a neurogenic tumor and a dysembryoma, respectively, experienced bleeding in the immediate postoperative period, which required prompt rethorascopy. Bleeding from an intercostal artery at a trocar insertion site was found in one patient, and was solved by coagulation and clipping; in the other patient, although no source of bleeding was apparent, removal of clots and irrigation with a saline solution stopped the hemorrhage. Both required two blood units each and were later discharged on the seventh and 12th postoperative day.

Another patient suffered from pneumonia and ARDS following the removal of an enterogenous cyst, and required assisted ventilation for 1 week and prolonged postoperative hospital stay (60 days).

The follow-up ranges from 1 to 75 months. No recurrences have yet been discovered in all patients operated on for stage-I thymoma at periodic chest CT scan follow-up, except for one patient, who had undergone resection for an encapsulated thymoma. At the moment of thymic resection, two very small intraparenchymal lung nodules (diameter < 5 mm) were already present in the lung parenchyma, but had been interpreted as fibrotic on the basis of a previous chest radiograph. Four years after the operation, the two nodules had increased in size and were followed by the appearance of two more lesions in the opposite lung that were diagnosed as thymoma metastases. The patient was therefore reoperated on in order to remove the nodules; at sternotomy, an undetected small neoplastic recurrence along the pleural aspect of the utility thoracotomy incision was also discovered.

Follow-up of patients affected by myasthenia gravis is carried out by a team of neurologists who are satisfied by the result of the surgical intervention.

## DISCUSSION

Mediastinal pathologies encompass a wide spectrum of diseases, each requiring different surgical procedures with varying levels of difficulty, ranging from diagnostic procedure to simple resection of pedunculated masses or to complex removal of large masses with tenacious adhesions or invasion of contiguous structures.

Whenever incisions such as a thoracotomy or a sternotomy would appear to be disproportionate with relatively simple resections, videothorascopy offers an alternative that allows wide exposure of the chest and of the mediastinum, and allows carrying

out all the surgical maneuvers required for the resection. Videothoracoscopy is indicated both for diagnosis and treatment.

Mediastinal diseases may be diagnosed with simple noninvasive procedures or may require complex and invasive procedures. CT is an essential diagnostic tool by which initial information regarding diagnosis and treatment can be achieved. Information on morphology, density, and vascular layout of the mass, its relationship with surrounding structures, the presence or absence of a capsule or a cleavage plane, as well as a clue to invasiveness, can all be gathered by this first diagnostic method. However, sensitivity and specificity are often inadequate, and further information can only be achieved by surgical exploration.<sup>11</sup>

Fine-needle aspiration and mediastinoscopy can provide further diagnostic opportunities, in case of a solid lesion and according to its site. These are usually unable to ensure a precise diagnosis in case of systemic lymphatic diseases, or in case of diseases that are difficult to type. Thoracoscopy in these cases provides an important diagnostic tool: the possibility of obtaining large samples, adequate for the most accurate histology, histoimmunology, and electronic techniques. The more recent chemotherapy protocols for malignant lymphohematologic diseases highlight the need of an extremely accurate typing of the neoplastic disease.

We believe that when the disease is totally confined to the mediastinum, thoracoscopy not only allows obtaining more adequate biopsy samples, but can also give information on the extent of the disease itself. Videothoracoscopy is also useful for evaluating the outcome of chemotherapy and for restaging, as well as for determining the nature of residual tissue of uncertain origin sometimes observed at radiology. The thymus gland, as a part of the lymphatic system, can be the site of persistence of a systemic malignancy; in our experience, this was confirmed thoracoscopically in six patients, and thoracoscopic thymectomy was then carried out.

Thoracoscopic approach to the diagnosis of systemic malignancies located in the mediastinum is still very controversial; many consider this approach excessive in comparison to other more traditional diagnostic options. We believe that this opinion may sometime be due to limited experience in applying videothoracoscopic techniques to mediastinal diseases. Indeed, routine application of these techniques can allow reaching a more precise diagnosis in little time and without any particular difficulty.

When considering the resective aspect of videothoracoscopy, care must be taken in order to distinguish diseases of true thymic origin from others. The indications for thoracoscopic thymectomy are un-

questionable in cases of benign diseases, as no oncologic concern arises. In some cases, for example pleuropericardial cysts, removal is very easy. Previously excluded from surgery because of the inevitable need of carrying out a thoracotomy, pleuropericardial cysts can now be removed thoracoscopically when the size is considerable, to prevent symptoms or to relieve any psychological problem on the patient's part regarding his disease.

Other cystic lesions, such as teratomas or dysembryomas, can also be treated likewise. These pathologies can be technically rather complex to remove, both thoracoscopically and thoracotomically, as their congenital nature accounts for the tenacious adhesions to surrounding structures so frequently observed. Large masses tightly and diffusely adherent to surrounding structures are in fact the main limit to thoracoscopic excision. The removal of any fluid present within the mass reduces the tension of the cystic wall and facilitates isolation from surrounding structures. However the operation can be considered achieved even though small portions of the cystic wall with particularly tight adhesions to vital organs, such as esophagus and bronchi, cannot be removed. This also occurs in conventional surgery.

In cases of malignancy, thoracoscopic removal, even though feasible, is absolutely contraindicated, as it cannot be justified oncologically.

Concerning videothoracoscopic treatment of thymic diseases, myasthenia gravis and neoplasms (thymomas and cysts) present different specific problems and implications.

Myasthenia gravis is usually associated with simple thymic hyperplasia, and much more rarely with thymoma. The surgical indication is given by the neurologists when the patient does not respond to medical treatment. The treatment of choice in this case is total thymectomy that can be performed thoracoscopically, avoiding a conventional approach through a cervical incision or a median sternotomy.<sup>12,13</sup> Thymectomy for myasthenia gravis is simpler than for thymoma because no mass impairs maneuvers.

The thymus can be completely removed using a left or right unilateral approach. However, since 1997, we have adopted a bilateral videothoracoscopic approach because of the need to remove all the fatty areolar tissue where thymic tissue is frequently detected. The thymus is then extracted through the utility thoracotomy.

Thoracoscopic excision for thymic tumors is still very much the object of debate. Thymic tumors are often well encapsulated, and removal is usually simple. Videothoracoscopy allows deciding if the procedure may be concluded thoracoscopically or whether conversion to thoracotomy is needed.



The surgical treatment of a thymoma is total thymectomy.<sup>13</sup> If the lesion is small, the tumor, together with all the adjacent thymic tissue, can be completely removed thoracoscopically. Even if modest, invasiveness represents an absolute contraindication to thoracoscopic resection, as invasiveness is more important than size in determining resectability. In our opinion, thoracoscopic thymectomy should be reserved for neoplasms that appear perfectly encapsulated both at traditional diagnostic procedures and direct observation, that are not > 3 cm in diameter, and that are completely enveloped by normal-appearing thymic tissue, which allows safer instrumental manipulation of the mass. Videothoracoscopic manipulation, though very precise and accurate also due to the magnified image of the operative field, can carry a higher risk of damaging the capsule than traditional surgery.

Due to the characteristic histology of thymic tumors, it is usually very difficult to be certain of an invasive attitude. The former criterion of macroscopic invasion of the capsule is still in use, but recent pathologic classifications also consider microscopic invasion of the capsule as a determinant to invasiveness.<sup>14</sup>

Even though no cases of chest wall recurrences from thymoma have yet been recorded in the literature, also because of the limited series available, we did unexpectedly encounter one case of recurrence on the site of the utility thoracotomy while carrying out a sternotomy for bilateral lung metastases from thymoma in a patient who had been operated by our team 3 years beforehand. This circumstance dampened our enthusiasm regarding videothoracoscopic excision of thymomas. Moreover, during the previous operation, the thymoma had been removed from the chest after having been placed in a plastic bag precisely in order to avoid seeding. We therefore believe that in this case possible hematogenous spread cannot be ruled out.

## CONCLUSION

We believe that a critical revision of outlook, indications, and attitude to videothoracoscopic approach to mediastinal disease is necessary. Videothoracoscopic can now attain a leading role in diagnosis and surgical treatment:

1. In cases of lymphatic diseases located primarily in the mediastinum, thoracoscopy allows for obtaining adequately large tissue samples that are essential for diagnosis and that are difficult to obtain otherwise.

2. Schwannomas, simple cysts, or other similar mediastinal growths can be very simply removed thoracoscopically, thus avoiding disproportionate thoracotomies.

3. Dysembryogenetic lesions can also provide a useful indication for thoracoscopic removal, even though prompt conversion to thoracotomy is mandatory in case of technical difficulties.

4. In case of myasthenia gravis associated with thymic hyperplasia, total thymectomy and resection of the surrounding fatty tissue can be carried out thoracoscopically. In case of thymic neoplasms, however, total thoracoscopic thymectomy must be limited to masses not > 3 cm in diameter, with an intact capsule and with sufficient surrounding thymic parenchyma to allow safe endoscopic manipulation, without risk to the tumor capsule.

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