Diagnosis and Treatment of Mediastinal Tumors by Thoracoscopy*

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Objectives: Thoracoscopic management of mediastinal tumors is still subject to analysis. Seventy-three patients underwent thoracoscopy for treatment of mediastinal masses and were analyzed retrospectively in order to evaluate the effectiveness and complications of the procedure.

Methods: Between 1983 and 1999, 21 conventional thoracoscopies and 52 video-assisted thoracic surgeries were performed (33 for diagnostic purposes and 40 for therapy). Patient ages ranged from 2 to 81 years (mean, 43.8 years) with a slight predominance of girls and women over men and boys (41 vs 32, respectively). All patients underwent general anesthesia using simple intubation (22 patients) or double-lumen intubation (51 patients).

Results: The histologic type of tumors was obtained in all patients. For therapeutic purposes, a change of procedure to thoracotomy was necessary in nine patients. The reasons for this change were tumor size, tumor invasion of nearby structures, difficulties in continuing the dissection, the performance of an upper lobectomy, and suturing the iatrogenic lesion of the diaphragm. Four patients died during the first 30 postoperative days as a consequence of their primary pathology.

Conclusion: Thoracoscopy was confirmed as an effective diagnostic and therapeutic alternative for the treatment of mediastinal disorders.

Key words: conventional thoracoscopy; mediastinal cysts; mediastinal tumors; thoracoscopy; video-assisted thoracic surgery

Abbreviation: VATS = video-assisted thoracic surgery

Varying approaches are possible for biopsies of mediastinal masses. The classic mediastinoscopy described by Carlens1 in 1959 provides a safe approach to the upper mediastinum, pretracheal and paratracheal spaces, and subcarinal lymph nodes. The anterior mediastinotomy proposed by McNeill and Chamberlain2 permits access to the anterior mediastinum, to subaortic and periaortic lymph nodes, and to the aortopulmonary window. Multiple lesions or those that are inaccessible by these methods can be diagnosed by thoracoscopy.3

A wide spectrum of technical difficulties exists in surgery for mediastinal diseases, ranging from the simple removal of a pedicled tumor to complex resections of large masses that are adherent to adjacent structures. Hence, the surgical removal of mediastinal tumors by thoracoscopy is still a reason for analysis. This is true not only because of the technical possibilities of the method, but, mainly, because of its viability and safety in manipulating important structures such as the pulmonary hilum, great vessels, and esophagus. In addition, it is effective in cases requiring radical surgery of malignant tumors.4 Currently, thoracoscopy can be a useful alternative for the excision of cystic lesions5,6 or benign mediastinal tumors, as well as for thymectomy in the surgical management of myasthenia gravis.7 The objective of this report is to analyze the
effectiveness and complications of conventional thoracoscopy and video-assisted thoracic surgery (VATS) in the diagnosis and treatment of mediastinal diseases that were indicated on our service.

**Materials and Methods**

This study was accomplished at the Hospital das Clínicas and Hospital Universitário of the University of São Paulo Medical School. It is a retrospective analysis of 73 thoracoscopies performed between August 1983 and April 1999. The information was obtained from medical records, and the mediastinal tumors were initially identified by simple chest radiographs and/or CT scans.

The procedures were divided based on the surgeon’s objective. Therefore, 21 conventional thoracoscopies (28.6%) were performed, 14 for diagnostic purposes and 7 for therapeutic purposes. Of 52 VATS procedures (71.2%) that were performed, 19 were for diagnosis and 33 were for therapy. We call a procedure diagnostic when a biopsy and/or staging of the tumor to verify the feasibility of complete resection is indicated. We call a procedure therapeutic when surgical removal of mediastinal tumors and cysts is indicated.

The effectiveness and complications of the procedures were analyzed considering the confirmation of the histologic diagnosis of the lesions, the operative time, the necessity for supplementary thoracotomy (conversion), the time period of postoperative drainage, hospital stay, and deaths.

Forty-one patients (56.2%) were female and 32 patients (43.8%) were male, with ages ranging from 2 to 81 years (mean, 43.8 years). The mean age between the two groups was similar.

All thoracoscopies were performed under general anesthesia with the patient in the lateral decubitus position. Double-lumen intubation was used in 51 patients (69.9%), and a simple intubation was used in 22 patients (30.1%). In 11 children (<12 years), the lung on the side where the procedure was performed was blocked when necessary, utilizing a catheter with a distal balloon or with selective intubation of the opposite lung.

For conventional thoracoscopy, a rigid thoracoscope (model 26038; Storz; Tuttlingen, Germany) with a diameter of 11 mm was utilized and was equipped with a 0° optical telescope and a 6-mm channel of instrumentation. The mediastinoscope adapted for thoracoscopy by Carlen also was employed occasionally. After 1992, VATS was performed with a rigid thoracoscope (model 7200B; Storz) that was 11 mm in diameter and a 0° and 30° optical telescope connected to a video camera (Dyocam 700; Dynonics; Berlin, Germany) and to the light source. Conventional surgical material was utilized for all procedures in case of conversion to thoracotomy.

In all patients, tubular multiperforated drains (18F to 36F) connected to an underwater seal were used at the end of the procedure. Antibiotics (cephalothin) were administered at the time of anesthesia and were continued until removal of the chest tube. Other medications included anti-inflammatories (indomethacin or diclofenac sodium) and opiates (pethidine hydrochloride) for analgesia, according to requirement or the patient’s request.

The tumor was located in the anterosuperior mediastinum in 18 patients (24.6%), in the mid-mediastinum in 28 patients (38.3%), and in the posterior mediastinum in 27 patients (37.1%). The diameter of the mediastinal tumors and cysts ranged from 2 to 21 cm (mean, approximately 8.3 cm).

Thirty-nine subjects (53.4%) were asymptomatic. Thirty-four patients (46.6%) complained of the following symptoms: chest pain (11 patients), myasthenic syndrome (4 patients), signs of compression of the superior vena cava (4 patients), hoarseness (3 patients), pain in the upper limb corresponding to the side of the tumor (3 patients), dysphagia (2 patients), dyspnea (2 patients), and various pains (5 patients). The symptoms were more frequent in patients with malignant lesions (68%).

**Results**

The histologic type of tumors was confirmed in all patients who were operated on for diagnostic reasons. Lymphomas predominated, followed by seminomas and other rarer tumors. Two patients presented with masses in the upper lobe of the right lung, simulating posterior mediastinal tumors. Biopsy confirmed one tumor as a squamous cell carcinoma and the other as an undifferentiated tumor, which was diagnosed only at surgery (Table 1).

The patients operated on for therapeutic purposes with total resection of the lesion demonstrated predominantly encapsulated neurogenic tumors (majority were schwannomas) and thymomas in the early stage. The remaining diagnoses included various cysts, thymic hyperplasia, and other rarer tumors (ie, teratoma, paraganglioma, lipoma, and leiomyoma of the esophagus) (Table 2).

Tables 1 and 2 demonstrate the prevalence of malignant lesions (40; 54.8%) over benign lesions (33; 45.2%) and also the preferred location of lesions in the anterosuperior mediastinum. There is a clear predominance of solid lesions (59; 80.5%) over cystic lesions (14; 19.2%).

Table 3 displays the mean duration of the procedures, the mean length of hospital stay, time of postoperative drainage, the necessity of conversion to thoracotomy, the complications, and deaths.

Conversion to thoracotomy was necessary in nine patients (12.3%), having diagnostic objectives in four patients, due to technical difficulties of dissection and/or the degree of tumor invasion, and having therapeutic objectives in five patients (three due to tumor size and invasion of adjacent structures, one for lobectomy of squamous cell carcinoma of the lung, and one for suturing an iatrogenic lesion of the

<table>
<thead>
<tr>
<th>Table 1—Thoracoscopy for Diagnostic Purposes</th>
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<tbody>
<tr>
<td><strong>Histologic Type</strong></td>
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</tr>
<tr>
<td>Hodgkin’s lymphoma</td>
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<tr>
<td>Non-Hodgkin’s lymphoma</td>
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<tr>
<td>Seminoma</td>
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<tr>
<td>Malignant thymoma</td>
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<tr>
<td>Teratoma</td>
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<tr>
<td>Inoperable schwannoma</td>
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<tr>
<td>Normal thymus</td>
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<tr>
<td>Undifferentiated cancer of lung</td>
</tr>
<tr>
<td>Squamous cell cancer of lung</td>
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<td><strong>Total</strong></td>
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Minimally Invasive Techniques
diaphragm). In seven patients with large tumors, almost all of the lesion was freed by thoracoscopy. Accessory thoracotomy, which could be considered on some services to be a routine procedure (incision \#5 cm), contributed not only to the removal of the lesion from the chest cavity, but also helped in the dissection and palpation of the adjacent structures. No patient required conversion because of bleeding.

The following complications occurred in 9.6% of patients: postoperative pleural effusion requiring drainage for 12 days (one patient); postoperative drainage required for 5 days due to an air leak and infection at the site of the anterior trocar; phrenic nerve lesions (one iatrogenic and the other of tumor invasion resected with the surgical specimen; two patients); lesion of the stellate ganglion (one patient); and lesion of the diaphragm (one patient) (Table 3).

The mean (± SD) follow-up time was 80 ± 42 months (range, 1 to 186 months) for about 77% of patients. There were no recurrences of the resected tumors up to the present time. Sixty-one patients (83.5%) considered the cosmetic result satisfactory immediately postoperatively, and no tumor implants were observed in the region of the trocar sites. Four patients (5.4%) died within 30 days after diagnostic procedures secondary to the course of the primary disease. These deaths occurred at the beginning of our experience in patients with advanced disease (superior vena cava syndrome secondary to lymphoma).

**Discussion**

Currently, various techniques exist for the diagnosis of mediastinal lesions. CT is considered essential and is important for displaying morphology, density, limits, and vascularization of these tumors. It often accurately defines the relationship of the lesion with the adjacent structures. Nevertheless, surgical biopsy still remains the most important tool in diagnosing these disorders.6,8 Clearly, biopsy procedures on nonresectable tumors and resections of benign cysts are less liable to produce complications when realized by VATS rather than by thoracotomy or sternotomy.9 VATS permits good exposure of the entire mediastinum, adequate space for almost all maneuvers of dissection, access to various areas, better evaluation of the anatomic relationship of the tumors, and, possibly, reduction of surgical trauma.

The aspiration of mediastinal tumors using a fine needle has been shown to be fairly safe.10,11 This is particularly so after the development of techniques and materials permitting needle biopsy guided by ultrasonography, fluoroscopy, or CT and obtained by the transthoracic, transesophageal, or transbronchial approach. Some authors12 confirm the diagnostic effectiveness of these methods. Nevertheless, uncooperative subjects, those who have chronic uncontrollable cough, severe pulmonary emphysema, coagulation disturbances, or undergone prior surgical procedures may not be ideal candidates for this procedure. The diagnosis of lymphoproliferative diseases by cytology testing alone is also difficult because of the vast cellular variation. Hence, the collection of various tumor specimens for the histologic analysis of lymphomas is more effective than the examination of needle-aspirated cells.

There are some studies comparing the effectiveness of different methods for diagnosis of mediastinal tumors, and opinions vary according to the author’s familiarity with different procedures or even with the technique employed.13,14 A prospective study by Gossot and colleagues,15 comparing mediastinoscopy with thoracoscopy for biopsies of mediastinal tumors, demonstrated similar diagnostic effectiveness. Nevertheless, complications were fewer and hospital stays shorter using mediastinoscopy.

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**Table 3—Thoracoscopy for Diagnosis vs Therapy**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Diagnostic Thoracoscopy (n = 33)</th>
<th>Therapeutic Thoracoscopy (n = 40)</th>
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<tr>
<td>Mean operative time, min</td>
<td>32.8</td>
<td>167.4</td>
</tr>
<tr>
<td>Mean pleural drainage, d</td>
<td>3.7</td>
<td>4.9</td>
</tr>
<tr>
<td>Mean hospital stay, d</td>
<td>6.3</td>
<td>7.5</td>
</tr>
<tr>
<td>Histologic diagnosis, %</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Conversion</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Complications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pleural effusion</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Air leak</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Phrenic nerve lesion</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Trocar infection</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Diaphragmatic lesion</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Deaths</td>
<td>4</td>
<td></td>
</tr>
</tbody>
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Furrer and colleagues\textsuperscript{16} contrasted the diagnostic effectiveness of cervical mediastinoscopy, anterior mediastinotomy, and VATS and reported that VATS provided the diagnosis in 100\% of cases, whereas diagnosis was made in 88\% of cases when using the first two techniques. In patients entered into a program of outpatient surgery and early discharge, Callejas and colleagues\textsuperscript{17} accomplished diagnostic exploration using the following three different methods: mediastinotomy, mediastinoscopy, and VATS. The authors demonstrated that these procedures are feasible and require \(< 24\) h of hospitalization. Solaini and colleagues\textsuperscript{18} reconfirmed that thoracoscopy is an effective method, especially for lesions that cannot be reached by mediastinoscopy. We feel that cervical mediastinoscopy is the procedure of choice for biopsies of superior mediastinal, paratracheal, or subcarinal tumors. Anterior mediastinotomy is indicated\textsuperscript{19} for tumors that are adherent to the anterior chest wall, for tumors that are located in the aortopulmonary window, or for periaortic tumors. However, thoracoscopy is an additional tool at the surgeon’s disposal, particularly in cases of tumors with difficult access that require direct vision, tumors with proximity to neurovascular structures, multiple lesions, or tumors needing many biopsies to obtain adequate amounts of material. Thoracoscopy is useful in staging a lesion prior to surgery and in evaluating the feasibility of complete resection. Thoracoscopy also has the advantage of being minimally invasive and cosmically more acceptable.

Up to the present time, the surgical resection of mediastinal tumors by conventional thoracoscopy or by VATS has been limited to cystic, encapsulated, preferably benign lesions that have not invaded neurovascular structures.\textsuperscript{5} Despite the controversy and discussion in the literature, complete surgical excision of cystic tumors of the mid-mediastinum, encapsulated thymic neoplasms, and benign neurogenic tumors of the posterior mediastinum can also be accomplished.\textsuperscript{20} The method continues to be contraindicated for malignant and invasive tumors, since the only technically accepted and oncologically correct resections are those accomplished via thoracotomy and/or sternotomy.\textsuperscript{20} The cost-effectiveness of these minimally invasive procedures compared with the analogous open procedures still remains to be determined. Notwithstanding a shortened hospital stay for many of these procedures, the equipment is more expensive, and a longer time in the operating room may be necessary.

The thorascoscopic procedure is considered safe and effective for children between 1 month and 18 years of age, not only for biopsies of tumoral masses,\textsuperscript{21} but also for the treatment of benign cysts.\textsuperscript{22} The only exception to this is when the tumors are compressive in nature, promote mediastinal deviations, and/or are located subcarinally with only difficult and dangerous dissections possible. For these situations, thoracotomy is still the method of choice. Although the method in this age group does not always significantly reduce the length of hospital stay, most of the time it is associated with an important reduction in morbidity for these patients.\textsuperscript{23}

The method is not completely free of risk, and some complications already have been reported. These complications are listed in Table 3 and include, for example, the following: intraoperative bleeding, sometimes severe enough to require immediate conversion\textsuperscript{9,20}; rupture of the intermediate bronchus during dissection, which can appear intraoperatively or immediately postoperatively\textsuperscript{24}; injuries to nerves or to the diaphragm; air leak; infections at the site of the trocars; and injury to the stellate ganglion. Other minimally invasive techniques, such as cervical mediastinoscopy and anterior mediastinotomy, are also not completely free of accidents, such as opening of the pleural space and/or injury to neurovascular structures.\textsuperscript{25}

The ratio of cystic lesions to solid lesions (1:4) in our series is similar to that reported by other authors\textsuperscript{9,20} (ie, there is absolute predominance of solid lesions in the mediastinum). Anterosuperior mediastinal tumors were the most common. The most prevalent diagnosis was neurogenic tumors (22.5\%) followed closely by thymic lesions (17.5\%). The former as well as the thymomas were encapsulated and easily removed. The most important factors for determining resectability and the possibility for the use of thoracoscopy were the presence of adhesions and/or invasion of adjacent structures rather than size of the tumor.

Operative time for VATS was longer than for conventional thoracoscopy, and the ratio of complications was also greater (Table 3). One explanation for this may be the complexity of the method and the surgical indications for this group. The English literature\textsuperscript{15} displays results and complications that are similar to those in this report.

During the manipulation of benign cystic lesions, the cystic cavities were opened and aspirated in order to simplify dissection and removal at the end of the procedure. In those cases in which it was necessary to leave small remnants of cysts adherent to vital structures, the mucosa was cauterized to avoid recurrence. Solid masses, which can contaminate the chest wall when they are removed through the incisions made for the trocars, were removed protected within extracting bags after widening the incisions.

Presently, the literature contains many contradictory points of view regarding the place of VATS in
the treatment of thymoma. In 1993, Sugarbaker\textsuperscript{7} wrote that “currently, thoracoscopic approaches to the anterior mediastinum should be limited to the performance of diagnostic biopsies and resection of cysts. Further applications for the therapeutic and radical resection of thymoma, awaits advances in both the instrumentation and technique.”

Kaiser,\textsuperscript{26} in 1994, proposed that VATS may be applicable in a number of patients with encapsulated lesions when combined with a transcervical approach to achieve total thymectomy for definitive therapy. Kaiser also reported the initial experience with and described the development of new instrumentation to perform these procedures. In the same year, Roviaro et al\textsuperscript{20} considered that total thymectomy is feasible and removed six thymomas, with no recurrence of the disease during the follow-up, which ranged between 4 and 28 months. Yim,\textsuperscript{27} in 1996, wrote that complete thymectomy could be accomplished, but we have reserved this approach for the resection of benign masses only. Noda et al,\textsuperscript{28} in 1997, removed a disseminated mass of thymoma by two-stage VATS (bilateral), and the patient was discharged 20 days after the second operation.

In our series, we performed seven resections of stage I thymomas (encapsulated), removing the entire gland including as much fatty areolar tissue as possible. All of these tumors have a diameter of at least 3 cm and were extracted inside a plastic bag through the trocar or utility thoracotomy incision. Until the present time, there have been no recurrences of the resected tumors in the mediastinum or in the trocar sites. But, we also agree with Khoman et al,\textsuperscript{29} who state that to compare VATS and the standard open procedure will take many years of investigation.

A mediastinal tumor can be simulated by a mass located in the medial portion of the lung or in the pleural leaflet, adjacent to the mediastinum or diaphragm. Their distinctive radiologic densities also differentiate the mediastinal structures that are in contact with the lung. Because their margins are in intimate contact with other structures of the same density, even CT scans sometimes fail to distinguish the location and/or origin of the tumors. Two patients in our series underwent surgery with VATS because of an apparent tumor in the posterior mediastinum, which was really a lung cancer located in the right upper lobe. After diagnostic confirmation in one subject, lobectomy was accomplished with lymphadenectomy through conventional thoracotomy. The patient’s course was uneventful, and he is still alive 3 years postoperatively. Only a biopsy was performed in the second patient because of the invasiveness of the tumor.

In conclusion, thoracoscopy is an effective diagnostic and/or therapeutic method that can and should be included in the operational routine of thoracic surgery for the treatment of mediastinal diseases. Thoracoscopy can be employed safely and effectively, and it is a procedure with low morbidity and reduced costs that requires shorter hospital stays.

References

19. Wychulis AR. Surgical treatment of mediastinal tumors: a 40
29 Khoman LJ. Controversies in the management of malignant thymoma. Chest 1997; 112(suppl):296S–300S