

Single centre experience in video-assisted thoracoscopic surgery resection of pleural schwannoma

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Background: Intrathoracic neurogenic tumor account between 12% and 21% of all mediastinal masses and represent for 75% of posterior mediastinal tumors and the elective treatment of these tumors is surgical excision, also if the outcome after minimally invasive excision has not well described yet. Aim of this study is to analyze the outcome of surgically treated patients especially regarding the use of minimally-invasive techniques.

Methods: We conducted a retrospective study on 28 patients surgically treated for posterior mediastinal tumors during the period from 1/1/2007 to 31/12/2018. Data regarding the surgical technique, intra-operative findings and post-operative outcome were collected and retrospectively considered.

Results: Muscle sparing lateral thoracotomy was performed in 8 patients while 20 patients underwent minimally invasive surgery: 11 were subjected to three-port video-assisted thoracoscopic surgery (VATS); 1 to two-port VATS; 5 to uniportal VATS and 3 to robotic excision. Histology proved the masses to be benign neurogenic tumors in all cases. Complete surgical excision was achieved in 26 patients, in the other two there were no recurrences of disease during follow up.

Conclusions: VATS is a reliable approach with better post-operative results than traditional surgery in the treatment of neuronal tumors. The thoracotomy approach to these tumors should be reserved for large tumors or those with an involvement of the vertebral canal.

Keywords: Mediastinal tumors; video-assisted thoracoscopic surgery (VATS); robotic assisted thoracoscopic surgery (RATS)

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Introduction

Intra-thoracic neurogenic tumor account between 12% and 21% of all mediastinal masses and represent for 75% of posterior mediastinal tumors (1,2). Histologically these masses derive from glial cells. Schwannomas and neurofibromas develop from nerve sheath, paragangliomas develop from paraganglions and ganglioneuromas and neuroblastomas from autonomic ganglions. These tumors

represent a benign condition, malignancy is unusual in adults (6% in adults versus 40% in children); in approximately 90% these masses arise from the intercostal nerve or the sympathetic chain region and between 10% and 20% have development within the spinal canal (3-5). Most patients are asymptomatic, the diagnosis is made during radiological examinations, normally whit chest radiographs or computed tomography performed to study other pathology (6). Although many patients are asymptomatic,

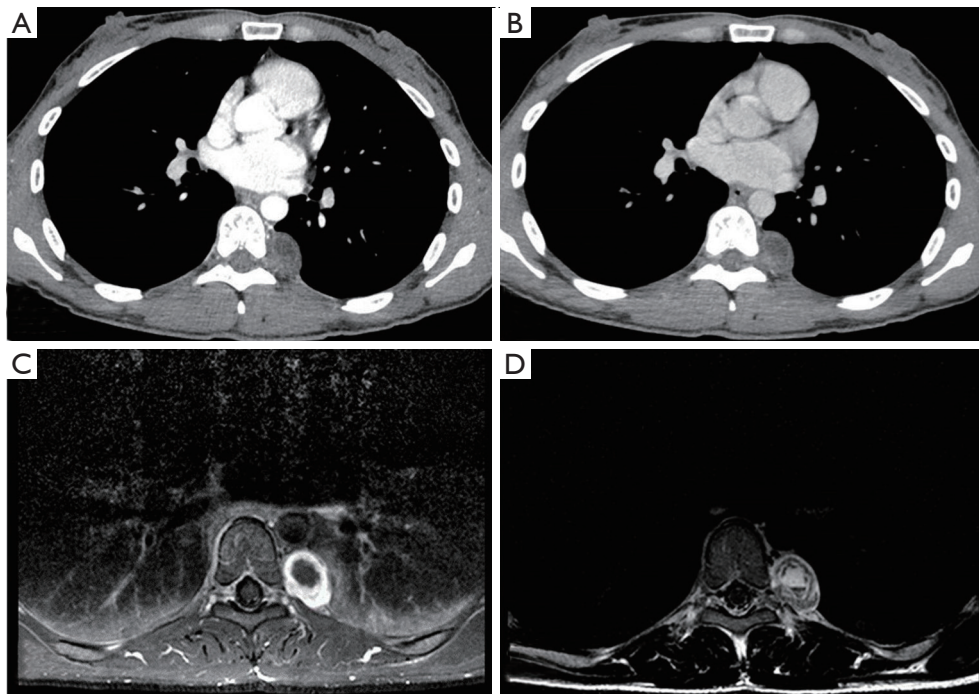


Figure 1 The sequence of images shows the CT and MRI in cross section; the lesion is highlighted in the left paravertebral area. MRI makes it possible to clearly define the relationships of the mass with the nerve roots and intervertebral foramen. The T1 and T2-weighted sequences highlight the capsular component of the tumor. (A) Chest CT scan with contrast, arterial phase; (B) chest CT scan with contrast, venous phase; (C) chest MRI scan with contrast, T1; (D) chest MRI scan with contrast, T2. CT, computed tomography; MRI, magnetic resonance imaging.

the surgical removal of these tumors is recommended in order to analyze them and prevent the evolution of rare malignant forms. Because of the high incidence of these tumors in the paravertebral region, traditional surgical approach consisted in a postero-lateral or posterior thoracotomy, also if minimally invasive techniques have been considered for these tumors in the last 10–15 years. Indeed, video-assisted thoracoscopic surgery (VATS) or robotic assisted thoracoscopic surgery (RATS) has proven to be an effective and safe alternative to thoracotomy in the treatment of these tumors. The aim of this study was to analyze 28 cases of intrathoracic neurogenic tumors, who underwent surgery at our department during the period 2007 to 2019 with particular attention on the use of minimally invasive techniques.

Methods

We conducted a retrospective study on patients underwent surgery for posterior mediastinal tumors among our department of general thoracic surgery between 1/1/2007

to 31/12/2018.

All patients were studied in the pre-operative setting by chest X-ray (CXR) and computed tomography (CT) with contrast. Magnetic resonance imaging (MRI) was performed in cases of tumors of the cervico-thoracic area to study the contiguity relationships with nerves and vessels, in cases of posterior mediastinal tumors with suspected involvement of the intervertebral foramen and in patients with neurogenic pain (*Figure 1*). PET-CT and preoperative biopsy with fine needle aspiration were performed in cases of suspicious malignancy at the preoperative imaging or to ruled out the possibility of metastases in patients with previous neoplasms. The preoperative setting also included electrocardiography, lung function tests, and standard laboratory blood tests. Data was collected analyzing each case for demographic data, clinical presentation, tumor characteristics, surgical approach, and surgical outcome. Regarding the surgical outcomes, the operative time, postoperative hospital stay, and postoperative pain, chest tube stay, and presence of complications has been analyzed. All patients were followed up at 6 months, 12 months and

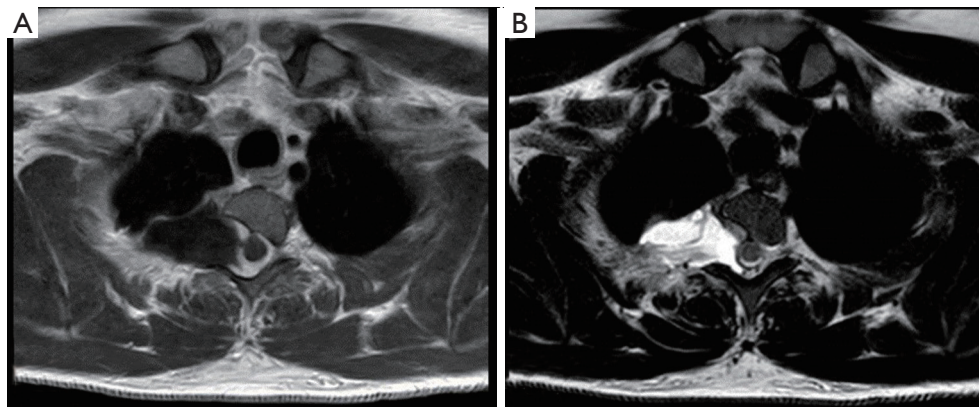


Figure 2 Description: the sequence of images shows MRI in cross section performed in follow-up after surgery; the right paravertebral lesion was removed with hemilaminectomy to achieve a widening of the intervertebral foramen and release the intraspinal component of the tumor. The T1 and T2-weighted sequences highlight the outcomes of the intervention and tissue rehash. (A) Chest MRI scan, T1-weighted sequence; (B) chest MRI scan, T2-weighted sequence. MRI, magnetic resonance imaging.

every 1 year after surgery with clinical interview and chest radiography, CT scan or MRI.

Surgical techniques

All patients underwent general anesthesia, were intubated with a double-lumen endotracheal tube and placed in lateral decubitus position.

In cases treated with open surgery, a muscle sparing lateral thoracotomy or a postero-laterale thoracotomy was performed at the level of the 5th or 4th intercostal space. In particular, a postero-lateral thoracotomy was performed especially in case of intervertebral foramen involvement with to aim to obtain more space for operation and eventual bone resection. Finally, 1 or 2 chest tubes were placed at the end of the operation.

In cases treated with the three-port VATS approach, 10 mm port for 30 degree camera the was placed through the sixth or seventh intercostal space on the middle axillary line; two working port (10 and 5 mm) were positioned according to the tumor location usually on the fourth intercostals space on the anterior axillary line and posteriorly on the fifth-fourth intercostal space. The tumor was extracted at the end of the surgery using an endo-bag through one of the port access, eventually increasing the surgical incision. Finally, one chest tube was placed usually from the camera port.

In two-port VATS technique the camera port was placed at the same position of the 3-ports techin10 mm port and service mini-thoracotomy were performed according to tumor location usually in the 4th or 5th intercostals space

between the middle and the anterior axillary line. The same extraction technique using endo-bag was made.

In uniportal VATS approach just a 3–4 cm access at the 4th or 5th intercostal space has been performed, according with Gonzalez Rivas technique, a wound protector (Alexis® S or XS) was placed and the chest tube was passed through the surgical wound at the end of the operation.

A 30 degrees 10 mm camera was used in all the VATS approaches.

In cases treated with robotic technique, 3 accesses were performed with 8 mm port and 30 degree camera. As in three-port VATS approach, telescopic camera was insert in 8 mm port through the fifth or sixth intercostal space and the other two 8 mm working ports were positioned according to the tumor location. As always an increase of one of the incision was prepared for tumor extraction using endo-bag and one chest tube was placed. Regardless of the approach used for surgical incision, the operation was performed by incising the pleura and limiting the crabbing on the tumor. Using a dissector, the tumor was mobilized with blunt dissection. Intercostal and vertebral vessels supplying the tumor have been isolated and closed with endo-clips or energy devices. In four case neurosurgeons were necessary to perform hemilaminectomy in order to achieve a widening of the intervertebral foramen and release the intraspinal component of the tumor (*Figure 2*).

In two cases VATS approach was integrated with a posterior surgical approach with partial vertebral resection without thoracotomy and without pleurotomy from the posterior.

Table 1 Demographic and clinical characteristics of patients (N=28)

Characteristics	n (%)
Age (years)	50±17.6
Male/female	5/23
Symptoms	
Asymptomatic	18 (64.3%)
Chest pain	4 (14.3%)
Cough	3 (10.7%)
Tachycardia	2 (7.1%)
Fever	1 (3.6%)
Right/left	13/15
Location	
Cervicothoracic	14 (50%)
Thoracic	7 (25%)
Thoracolumbar	7 (25%)
IIF	4 (14.3%)
Tumor size (mean) (cm)	4±1.9 (range, 2–8)

IIF, involvement of intervertebral foramen.

Results

During the study period, 28 patients were treated for posterior mediastinal tumors, eight underwent open surgery (performed by thoracotomy) and twenty underwent mini-invasive surgery, performed by VATS or RATS. The average age was 50±17.6 years, eighteen patients were asymptomatic, two performed CT scans during tests for tachycardia, three for persistent cough and four was initially subjected to MRI for persistent neurogenic chest pain. Dysphagia was not reported in any patient. Population characteristics and clinical data are summarized in *Table 1*.

Sixteen patients were studied with MRI, four performed PET and five patients underwent histological typing before surgery.

In our records of cases, 8 (28.6%) patients underwent traditional surgery with muscle sparing lateral thoracotomy (4 in the 5th intercostal space, 3 in the sixth and one in the third), while 20 patients underwent minimally invasive surgery: 11 (39.3%) were subjected to three-port VATS; one (3.6%) to two-port VATS; 5 (17.9%) to uniportal VATS and 3 (10.7%) to RATS (*Table 2*).

No case of mini-invasive surgery required conversion to thoracotomy. Neurosurgeon intervention was necessary

Table 2 Intraoperative and post-operative outcome in the 28 patients

Variable	n (%)
Operation time	128.6±58.7
Postoperative chest tube removal (day)	3.1±1.1
Postoperative hospital stay (day)	3.6±1.6
Follow-up (month)	68.4±34.5
Pathology	
Schwannoma	22 (78.6%)
Neurofibromas	5 (17.9%)
Paraganglioma	1 (3.6%)
Surgical approach	
Thoracotomy	8 (28.6%)
Three-port VATS	11 (39.3%)
Two-port VATS	1 (3.6%)
Uniportal VATS	5 (17.9%)
Rats	3 (10.7%)
Mortality rate	0
Morbidity rate	6 (21.4%)
Pleural effusion	3 (10.7%)
Fever with leukocytosis	1 (3.6%)
Postoperative radicular pain	2 (7.1%)

VATS, video-assisted thoracoscopic surgery.

in four cases to perform hemilaminectomy for a complete tumor excision from intervertebral foramen. In two cases the neurosurgical intervention was performed in combination with the VATS approach. Complete surgical excision was achieved in 26 patients, in two patients undergoing surgical hemilaminectomy, a small part of the tumor capsule was not removable from the vertebral canal and spinal nerves. Not reoperation was required, patients were checked with MRI and no disease recurrences occurred. There was no significant intraoperative blood loss and no major surgical complications occurred.

Mean operation time resulted of 111±46 (range, 53–206) minutes in minimally invasive surgery *vs.* 90±42 (range, 54–169) minutes in open surgery.

Not post-operative mortality was observed. Postoperative morbidity rate was 21.4%. In particular, complications occurred in 3 patients after VATS and in 3 patients after thoracotomy.

Minor postoperative complications were represented by pleural effusion (3 patients), fever with leukocytosis (1 patient) treated with antibiotics, prolonged postoperative radicular pain managed with opioid (2 patients). In one case a patient re-admission was necessary due to increased pleural effusion associated with fever which required placement of chest tube and antibiotics treatment. Histology proved the masses to be benign neurogenic tumors in all cases, with mean size of 4 ± 1.9 cm (range, 2–8 cm). In our data twenty-two cases were schwannoma (78.6%); five cases were neurofibromas (17.9%) and in one case paraganglioma (3.6%). At a mean follow-up of 68.4 months (± 34.5) no patients showed recurrence of the tumor.

Discussion

Intrathoracic neurogenic tumors, despite being rare presentations, represent about 75% of posterior mediastinal tumors. These tumors represent a benign condition and malignancy is unusual in adults. In 90% of cases these tumors originate in the paravertebral site and between 10% and 20% have development within the spinal canal requiring a multimodal approach to treat it. Neuronal tumor has several variants that can be easily confused with other less frequent lesions in the posterior mediastinum such as Bronchogenic cyst, hydatid cyst and lymphangioma. An accurate pre-operative planning with chest CT with contrast is essential to choose the best surgical strategy and avoid incurring vascular or neuronal damage that could lead to post-operative complications. MRI represents the gold standard for the study of the relationships between tumors of the posterior mediastinum and the vertebral canal and is essential to establish the need to associate neurosurgical approach. In our series 28 patients had tumors located in the posterior mediastinum; 14 (50%) were located in the cervicothoracic region; 7 (25%) in the thoracic region and 7 (25%) in the thoracolumbar region; in 4 (14.3%) cases tumors were involved the intervertebral foramen requiring neurosurgical intervention. Normally these tumors are asymptomatic and, in our series, only 10 (35.7%) patients presented clinical symptoms. In our records of cases symptomatic patients are less than other published series that reporting a range of 45–50% and 6–13% of patients with pulmonary symptoms and neurological symptoms respectively (7–9). During our experience there was no significant intraoperative blood loss and no major surgical complications occurred, independently by the surgical

approach. Not post-operative mortality was observed. Postoperative morbidity rate was acceptable (21.4%), and consisted only in minor postoperative complications represented by pleural effusion (10.7%), fever (3.6%) and prolonged postoperative pain (7.1%). Our data are in line with the data reported in literature, consisting in a morbidity rate were between 15–25% (10–12). In those series, minor postoperative complications were represented by prolonged postoperative radicular pain, pulmonary atelectasis, wound dehiscence, phrenic nerve palsy, Horner's syndrome, brachial plexus injury. Rarely in cases required a combined approach with neurosurgeons, cerebrospinal fluid leakage was reported.

We did not experienced nervous system-related complications, with only post-operative chronic pain probably due to intercostal nerve involvement.

In our records of cases no case of mini-invasive surgery required conversion to thoracotomy. The reported conversion rate in literature ranges from zero to 30.7% (7,8) and was mainly due to the size of the tumor and the need to proceed with a neurosurgical approach in cases of spinal tumor involvement. In our series, patients selected for minimally invasive treatment did not presented suspect of intra-foramen involvement or, if suspected, was judged susceptible of resection without conversion. The choice of the type of surgical approach was carefully decided after revision of the imaging (also integrating the CT scan with the MRI) in a multidisciplinary discussion with radiologist and spine surgeon. Probably this multidisciplinary approach permitted to avoid conversions during minimally invasive surgery and may be considered in this tumors management. Moreover, VATS and in particular Uniportal VATS approaches increased in the last 3 years, and the skills acquired permitted a better management also of complex cases without needed of conversion. Another point of interest regarded the possibility to combine VATS resection with posterior partial vertebral resection without thoracotomy, using a “service access” posterior directly on the vertebral resection. This kind of approach was performed in 2 patients with good results.

In different review statistical analysis showed differences between the traditional surgery group and VATS group in favor of minimally invasive surgery with less mean operative time, less median postoperative hospital stays and less median postoperative pain (8,11,12). In particular, VATS resection presented a remarkable intra-operative time, shorter than open surgery, also if this consideration

may be evaluated also considering the complexity of the intervention (7,9,10). Indeed, in our experience, open approach was associated in 4 cases with the needed of a vertebral resection and intra-foramen inspection performed by a spine surgeon, with inevitable time increasing.

On the other hand, especially in Schwannomas with extra-foramen presentation, VATS permitted a rapid and safe resection and presented clear advantages compared open surgery. On the other hand, VATS resulted with similar operation time compared with open surgery, may due the long time in the two intervention needed an external spine approach for a complete resection.

This study has some limitations, the first due its retrospective nature. Another limitation regarded the relatively small number of patients, especially in the open surgery group, that not permitted to do statistical consideration for an inappropriate comparison among small sub-groups. Conversely, we reported a good outcome and an interesting experience regarding the surgical treatment of these quite rare tumors, confirming the important role of minimally invasive technique also for these cases.

Conclusions

In our study we found that surgical treatment of neurogenic tumors in the posterior mediastinum is effective and safety. Minimally invasive technique and in particular a VATS approach is a reliable approach for the treatment of these tumors, while the thoracotomic approach to these tumors may be reserved for large tumors (more than 8 cm) or those with an involvement of the vertebral canal. Posterior approach with laminectomy plus thoracotomy/VATS can be used for patients with tumor involvement of vertebral canal and spinal nerves, but needs a combined multimodal approach with spine surgeons. Planning the correct surgical treatment is fundamental and requests the involvement of radiologist, thoracic surgeon and spine surgeon. Further studies are needed to validate and confirm data on the effectiveness of these treatments.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This study was approved by the Institutional Review Board of Catholic University of Sacred Heart (Rome) and individual consent for this retrospective analysis was waived.

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