



Robotic resection of posterior mediastinal lesions: indications, tips and tricks

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Abstract: The video-assisted thoracoscopic resection of posterior mediastinal lesions is feasible and safe in the majority of cases and is associated with a significant reduction of hospital stay, chest tube duration as well as a sensible reduction in patient's morbidity and mortality. However, we have to consider that some of mediastinal lesions can present anatomical features that make a traditional VATS approach technically challenging or at risk of injuring surrounding structures. In these patients that could be excluded from a traditional VATS approach, the robotic assisted procedure could be effective in resecting lesions that would otherwise require an open resection. Moreover, the robotic technique, extending the ability in the surgical tissue dissection thanks to three-dimensional view and dexterity due to the use of endowrist, can reduce the risk of damage to mediastinal structures and blood loss. As happened in general surgery for upper GI, prostatectomy or low rectum resections, the robotic surgery can be indicated for procedures in narrow space like the thoracic inlet or the posterior pericardiophrenic angle, where the traditional minimally invasive surgery shows technical limitations due to the use of straight instruments.

Keywords: Robotic surgery; posterior mediastinum; neurogenic tumor; minimally invasive surgery

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Introduction

Large reviews about the video-assisted thoracoscopic resection of posterior mediastinal tumors confirm that the VATS approach is feasible and safe, associated with a significant reduction of hospital stay and chest tube duration, as well as a sensible reduction in patient's morbidity and mortality (1). Despite the clinical advantages of the minimally invasive approach for posterior mediastinal lesions, we have to consider that some of them present anatomical features that make a traditional VATS approach technically challenging or at risk of damaging the surrounding structures (2). In these patients a robotic

assisted procedure could allow resection of posterior mediastinal tumors that would otherwise require an open approach, reducing the risk of intraoperative injuries. The robotic technique is able to extend the surgeon ability in tissue dissection, thanks to three-dimensional view and the dexterity due to the use of endowrist (3). As in general surgery for upper GI or for perineal surgery, like prostatectomy or low rectum resection, the robotic surgery is indicated for procedures in the thoracic outlet or the pericardiophrenic angle where the traditional mini-invasive surgery shows technical limits due to the use of straight instruments.



Figure 1 Gastro intestinal stromal tumour of the lower third of the esophagus.

Anatomical considerations

The posterior mediastinum is defined as the space located between the two pleural sacs, bordered superiorly by the thoracic inlet, inferiorly by the diaphragm, anteriorly by the pericardium and posteriorly by the spine, including paravertebral space (4). It contains several structures: descending aorta, esophagus, azygos and hemiazygos vessels, sympathetic chain, vagus and splanchnic nerves, thoracic duct, lymph nodes and adipose tissue. Among the masses that can be found in this compartment, the most common are neurogenic tumors (60%); they arise from the intercostal nerve sheath in the 90% of cases (schwannomas and neurofibromas), but they can also originate from the sympathetic ganglia (neuroblastomas, ganglioneuroblastomas and ganglioneuromas) or the paraganglionic cells (pheochromocytomas and non-chromaffin paragangliomas). Though frequently asymptomatic, some tumors, especially if malignant, can be accompanied by clinical manifestations due to bone erosion or involvement of nerve roots and other surrounding structures, as well as hormones production, such as in pheochromocytomas or neuroblastomas. Sometimes they can develop a spinal canal component (the so called dumbbell tumors) connected to the main mass by a small pedicle passing through the neural exit foramen. Neoplastic masses can also be represented by chordomas, chondrosarcomas, Ewing's sarcomas, esophageal neoplasms, lymphomas, invasive thymomas or metastases. Besides tumoral masses, posterior mediastinum can contain cystic lesions, vascular or spinal abnormalities (aortic aneurysm, varicose veins, lymphangioma or meningocele) and

infectious or inflammatory diseases (paraspinal abscess, mediastinitis, sarcoidosis, lymphoid hyperplasia or pancreatic pseudocysts). Mediastinal foregut cysts are due to abnormalities during the embryogenic development of the primitive foregut; they include bronchogenic cysts, esophageal duplication cysts and neurenteric cysts. Bronchogenic cysts are unilocular, lobulated, fluid-filled lesions, usually detected in the carinal region. Esophageal duplication cysts are typically found in the lower mediastinum; they develop along the esophagus, often intramurally, but they rarely communicate with the esophageal lumen. Neurenteric cysts usually take place in the right hemithorax, above the carina; they communicate with the meninges and are associated with vertebral abnormalities, as well as intestinal duplication, imperforated anus and congenital heart disease.

Preoperative surgical considerations and indications for robotic assisted procedure

As described above, there are many types of pathologies that could rise in the posterior mediastinum. The first step in the preoperative assessment is to evaluate if the lesion is radically resectable and, in that case, to choose the proper technique (open surgery *vs.* minimally-invasive procedure). Solid lesions along the costo-vertebral space, especially the ones with a large contact surface, could be cell B lymphomas, in which a simple VATS biopsy is required. On the contrary, in case of giant lesions open surgery must be considered, not only for the problems related to the surgical dissection and to the risk of rupture and seeding, but also for the involvement of surrounding structures like shown in *Figure 1*, an esophageal gastrointestinal stromal tumor that required a thoracic esophagectomy and gastroplasty. After these preliminary considerations, we could divide the posterior mediastinal lesions in solid, semi-solid or cystic, and cystic with air. The latter ones are the rarest, tracheal diverticula that usually develop in the upper posterior mediastinum and frequently in the thoracic inlet (*Figure 2*). The precise dissection around the esophagus, with the closure of the small communication with the tracheal lumen at the thoracic inlet, is easier with a robotic assisted procedure compared to traditional VATS (*Figure 3*). The cystic and semi-solid lesions can rise along the entire posterior mediastinum and they can have a wide range of dimensions; they are benign and a minimally invasive approach is beneficial for the patients. The cystic lesions of the posterior mediastinum can be easily resected with



Figure 2 Tracheal diverticulum of the thoracic inlet.



Figure 3 Robotic resection of a tracheal intra-thoracic diverticulum (5).
Available online: <http://www.asvide.com/article/view/31762>

a VATS procedure; however, in case of lesions more than 4 cm located in the upper posterior mediastinum, thoracic inlet or cardio-phrenic angle, close to the esophageal hiatus or inferior cava vein, the robotic approach gives substantial advantages. The first one is the opportunity to make a precise dissection of a large surface reducing surgical time and risk of intraoperative injuries of surrounding structures; the second is the possibility to visualize tiny vascular or lymphatic structures, like in case of mediastinal cystic lymphangiomas (*Figure 4*), reducing the risk of chylothorax or recurrences as shown in *Figure 5*. As reported in upper GI, the robotic surgery overcame some technical aspect of esophageal surgery; the same thing can be affirmed in case of big cystic para-esophageal lesions. *Figure 6* shows a rare case of branchial cyst close to the lower esophagus, easily resected with robotic technique without any esophageal injury. The solid lesions of posterior mediastinum are usually neurogenic tumors and easy to resect in VATS. However, also in these cases, there are some localizations in which robotic surgery makes the procedure easier and safer. Neuroinomas of the first rib (*Figure 7*) can be resected by a robotic procedure in a fast and precise way; the risk of a Horner syndrome due to a stellate ganglion injury is high and it is mandatory to achieve all the possible precautions to preserve it. Other than the radicular nerves, at that level even the sympathetic chain is often involved (*Figure 8*) and, for this reason, the use of Harmonic scalpel or

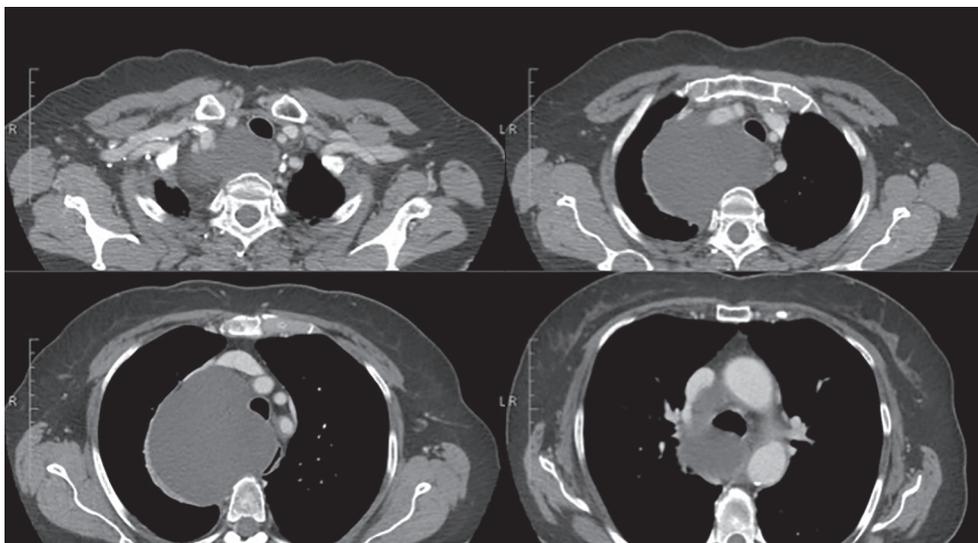


Figure 4 Cystic lymphangioma of the upper posterior mediastinum.



Figure 5 Robotic resection of a cystic lymphangioma (6). Available online: <http://www.asvide.com/article/view/31764>

advanced bipolar should be recommended (*Figure 9*). Some neurogenic tumors can rise in the middle mediastinum; also in this case the robotic technique allows the dissection in the retro-caval space and around the trachea, as shown in this case of Schwannoma of the middle mediastinum (*Figure 10*).

Surgical technique

In an effort to standardize the robotic surgical technique for each surgeon, considering the rarity of these lesions, we suggest to insert the robotic trocars along the 9th intercostal space, as reported for robotic lung lobectomy. This

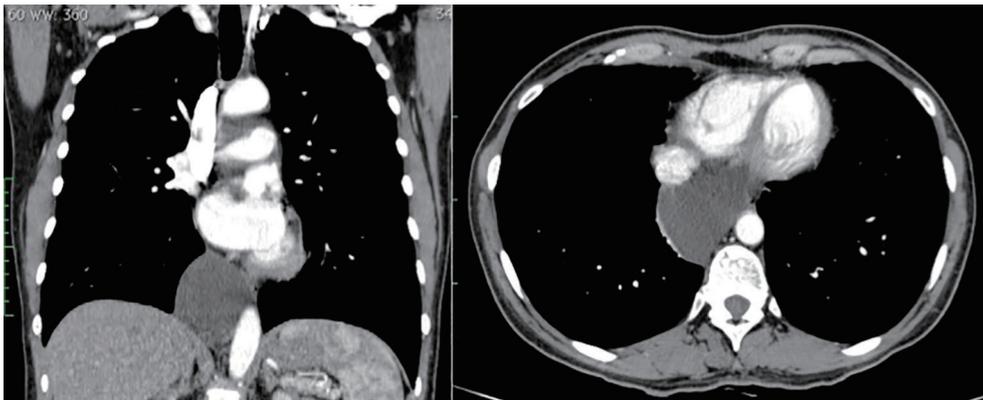


Figure 6 Para-esophageal branchial cyst of the lower posterior mediastinum.



Figure 7 Neurinoma of the first rib.

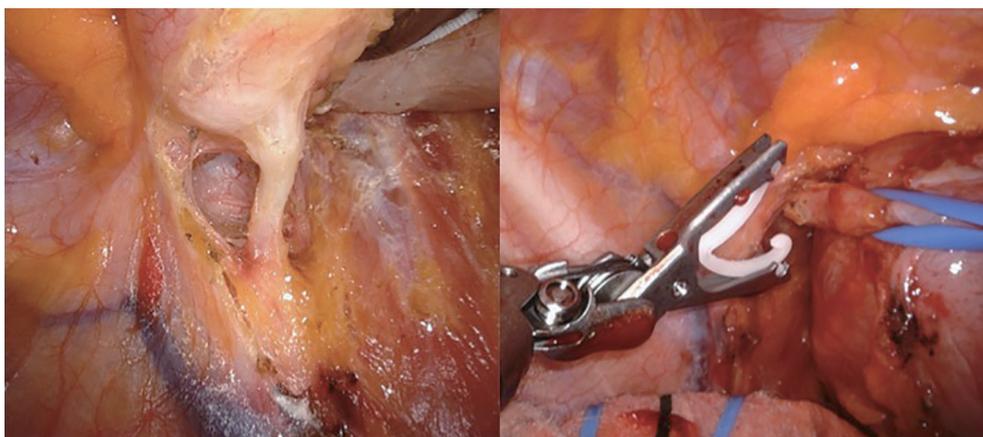


Figure 8 Precise dissection of the nerve root and the neurinoma by the harmonic scalpel. The nerve was clipped with robotic Hem-o-lok.



Figure 9 Robotic resection of a first rib neurinoma (7).
Available online: <http://www.asvide.com/article/view/31765>



Figure 10 Schwannoma of the superior mediastinum.

disposition enables to explore all the posterior mediastinum from the thoracic inlet to the esophageal hiatus. The use

of CO₂-inflation, as advocated in some reports, is not necessary in the majority of procedures (8); it is useful only to push down the diaphragm in case of very deep lesions in the posterior costo-phrenic space. For dissection we suggest unipolar hook or the most gently bipolar Maryland forceps. In these cases all the robotic trocars can be positioned along the 9th intercostal space. In our center we prefer to use the robotic harmonic scalpel in the effort to reduce intraoperative bleeding and lymphatic leak or nerves injury. Because the harmonic scalpel is not articable, it should be positioned in the 5th intercostal space on the right side and in the 9th on the left, maintaining the instrument on the right hand of the surgeon (opposite for left hand). Then, in our technique, three accesses are performed in the 9th intercostal space, approximately 8 cm between each other, starting from the camera port (12 mm) on the middle axillary line and continuing posteriorly for the second and third arm placement. The fourth arm is located in the 5th intercostal space on anterior axillary line, usually equipped with the tip-up forceps for the lung management (*Figure 11*). The cystic lesions should be dissected from the surrounding tissue trying not to open the capsule and with the effort to close all vascular, lymphatic or airway communications. In case of cysts of the lymphatic duct, usually located in the left side, it is of utmost importance to close the afferent and efferent lymphatic vessels to prevent an important and dangerous postoperative chylothorax; in those cases the use of robotic Hem-o-Lock can improve the lymphatic sealing. In case of suspected oesophageal duplication cysts, an oesophageal endoscopy is recommended to exclude an asymptomatic diverticulum and confirm the separation from the oesophageal lumen.



Figure 11 Standard trocars position for robotic 4 arms docking. This docking allows to explore all the posterior mediastinum.

Conclusions

In case of resectable posterior mediastinal lesions, minimally invasive surgery improve patients outcome in terms of postoperative recovery, pain control and hospital stay. However, the robotic assisted excision of posterior mediastinal tumour is still limited and few cases are reported in literature (9-11). Because of the costs, the robotic surgery should be reserved to patients with lesions that are difficult to resect with traditional VATS procedures or in whom there is a high risk of injury of surrounding structures. The role of robotic surgery should be to offer minimally invasive surgery to patients that would be excluded from a traditional VATS procedure. The possibility to have interchangeable and precise instruments allows dissection in small spaces and close to crucial structures avoiding complications or partial anatomical resection (12,13).

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