Editorial

From manual to robotic video-assisted resection of posterior mediastinal masses

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Guo and colleagues described the technique of a robotic-assisted resection of a posterior mediastinal mass, using a three arms robotic approach with the aid of CO_2 insufflation, and concluded that this approach was efficient and reliable (1). During the last 10–15 years the robotic-assisted approach has become a consolidated alternative technique to traditional video-assisted surgery and open approach, for the treatment of many thoracic diseases (2).

Posterior mediastinal masses are in the majority of cases represented by intrathoracic neurogenic tumors (75% to 95%), that count for about 19–39% of all mediastinal tumors (3,4). Malignancy rate is very low, reported in around 4% of the cases, and the lesions are often completely asymptomatic (3,5). In around 20% of cases excessive enlargement of the lesions can cause compression of neighbouring structures, bone erosion or spinal invasion, causing symptoms like chest pain, cough, dyspnoea, dysphagia, Horner's syndrome or neurological abnormalities (5,6). Generally neurogenic tumors are grouped in three categories, according to their site of origin. Those originating from peripheral nerves are neurofibroma, schwannoma or neurilemmoma, neurofibrosarcoma and neuroma (a post-traumatic lesion, appearing at the end of the severed nerve). The lesions that origin from sympathetic ganglia are neuroblastoma, ganglioneuroma and ganglioneuroblastoma. Finally, neurogenic tumors can rarely origin from parasympathetic ganglia like paraganglioma (3,7,8).

Once the traditional surgical treatment was a complete resection with a wide posterolateral thoracotomy and division of latissimus dorsi muscle (3). This choice is still today considered by many surgeons in case the tumor is large, it invades intraspinal tissues (the so-called "dumb-bell tumor"), it is localized in narrow spaces of the mediastinum, the first or second rib cannot be visualized and in case of pleural adhesion or bleeding (9,10). In case of a dumb-bell tumor, because of the intraspinal invasiveness, the combination of neurosurgical and thoracic approach is sometimes necessary to minimize morbidity and mortality (3,6). A supraclavicular approach is recommended for the resection of tumors arising from the brachial plexus (11). One of the alternatives to the posterolateral thoracotomy was the less invasive transaxillary approach described by Becker and Munro (12) to treat 13 cases of mediastinal tumors, including neurogenic lesions. These were resected extrapleurally with reduction of postoperative pain, less morbidity and quicker return to normal activity compared to the traditional posterolateral thoracotomy (12).

Despite the many efforts to make the traditional surgical technique less traumatic, the need for innovative and increasingly minimally invasive techniques began to be felt. With the advent of video-assisted thoracoscopy (VATS) before and robotic-assisted thoracoscopy (RATS) after, the minimally invasive techniques started to be considered even for the excision of posterior mediastinal lesions (3).

After the publication of Landrenau's report in 1992 the VATS for the excision of mediastinal lesions has been widely accepted (13,14). Conventional thoracoscopy allows visualization and removal of these lesions with small instruments and scope ports and less muscle injury. Large reviews on the video-assisted thoracoscopic resection of posterior mediastinal tumor showed that the VATS approach was feasible and safe with reduced duration of hospital stay and chest tube maintenance, with less morbidity and mortality for the patient (15).

A contraindications to VATS approach, as cited by Roviaro *et al.* (16), should be considered the presence of malignant features for the risk of local recurrences and bad prognosis (5,16). Others considered that contraindications should not be related to the degree of malignancy, but rather to the dimension of the mass and to the presence of intraspinal growth (13).

According to the dimension, Li and Wang (17) reported their experience with 58 patients. They established a cut off of 6 cm for tumors of the apex to undergo easy and complete thoracoscopic resection, over which operative time, blood loss and the incidence of post-operative complications were increased, and concluded that tumor diameter is the principal determinant for surgical indication to VATS (17). Conversely, a recent experience by Ciriaco and co-workers (8) demonstrated the excision of 7–8 cm posterior mass via thoracoscopic surgery, simply enlarging one of the thoracoscopic access, and using an endo-bag to facilitate the passage through the incision and avoiding seeding.

About intraspinal invasiveness Vernissac and colleagues (13) have demonstrated that a combined video-thoracoscopic approach with neurosurgical laminectomy is feasible and safe. Their 10-year experience shows the radicality and safety of VATS procedure, even for the resection of apical lesions, close to Adamkiewicz artery (5,10,13). In fact, low mediastinal posterior tumors may take origin near this important artery. This vessel, also called arteria radicularis magna, origins from the posterior branches of the intercostal arteries at a level that varies mainly between T8 and L1 with major incidence on the left side (70%) (18). Loss of this artery could lead to spinal cord injuries or ischemia (10,17). A coordinated approach with neurosurgeons is important for a successful excision of these tumors and better outcome.

With the advancement of the sophisticated technology of computer mediated surgery and the ascending development of the robotic devices, the technical limitations of manual VATS became more and more evident. These limitations render the dissection not so intuitive and easy, in particular because these tumors are characterized by strong adhesions and often narrow sites (9,19). Cerfolio *et al.* assert that posterior neurogenic tumors are difficult to remove both robotically and thoracoscopically and underline the additional difficulty in VATS to introduce the surgeons fingers or ports because ribs are closer together posteriorly (20). For these reasons robotic technique can extend the ability in the mediastinum, thanks to three-dimensional visualisation, dexterity and more accurate dissection, allowing resection of posterior mediastinal tumors, that, otherwise, would require an open resection (9).

In literature there are still limited experiences describing robotic-assisted excision of posterior mediastinal lesions (5,9,19,21). The first case of robotic resection of such a lesion was about a bronchogenic cyst, described by Yoshino and colleagues in 2002 (19). After this case other series or case reports have been described (20,22) showing that robotic was comparable, if not superior, to VATS in terms of morbidity, hospitalisation and conversion rate.

One aspect to consider with RATS is the need for the surgeon to adapt an advantageous technique to the anatomical features of the mediastinum. Cerfolio claims that the usual robotic pattern, used for lung resections, is not good for posterior mediastinal lesions. According to the site of the lesion, his proposal is to place the camera anteriorly and the robot posteriorly; in his opinion this easier scheme is not widespread used because many teams are unaware of it (20). Another workaround is the use of CO_2-insufflation, that is often recommended but not always necessary, like in the case reported by Nguyen and coworkers (23), who are used to insert robotic tools directly through the access without trocars. Moreover, according to the experience described by Al-Muffarej and colleagues (9), RATS approach is their main choice for excision of posterior mediastinal tumors, thanks to the numerous advantages of the same techniques (i.e., endowrist instruments) (9), with the only exception of extremely large tumors (>10 cm), in which an open approach is recommended. In case of robotic resection of an apical mass, at the level of the third rib or higher, they recommend to leave the apical portion as the last area mobilized. In this way, more traction can be applied on its apical portion, while dissecting it, avoiding potential damage to the stellate ganglion and subclavian vessels (9).

On the other hands, drawbacks of robotic technique has also been described; it is expensive, needs a specialized surgical team and it lacks tactile feedback (9).

Regarding the high costs to date, only one producer has marketed a robotic devices, Intuitive Surgical's da Vinci system (Sunnyvale, CA, USA), but new robots are being developed by Medtronic and by Verbsurgical. The entry of these new systems, hopefully along with others, into the market is highly desirable and will determine the reduction of costs and, hence, permit this technology to become available for the wider community (22).

The robotic apparatus requires meticulous preparation in terms of set-up and placement at the operating table and the transition from traditional surgery to totally robot-assisted surgery is not immediate. Thus a precise organizational and didactic routes must be followed with dedicated courses that provide the surgeons and surgical teams with confidence when operating with the robotic system. After the initial theory course, the use of a simulator is an important step in learning robot-assisted procedures and training at the console becomes the surgeon's first real contact with robot-assisted surgery. The most frequent procedure used in the initial phase of the learning curve is just the treatment of mediastinum lesions, like neurinomas as Cerfolio *et al.* suggest (21). These procedures represent an ideal training model because they provide the means for learning basic procedures combined with a relatively simple technique.

The lack of tactile feed-back remains unsolved today, although technology is available, it seems not to be affordable on large-scale, due to cost issues and to the fragility of the sophisticated sensors that must be applied at the tip of each instruments. We must note that the other technical advantages of the robotic system like the high degrees of movement freedom, dexterity, and improved visualisation, largely compensate the lack of tactile feedback.

The case report described by Guo *et al.* at the Ruijin Hospital of Shanghai is another example of the effectiveness of the excision of a neurogenic tumor, a neurofibroma, by robotic-assisted technique, without postoperative complications and morbidity for the patient. They describe the surgical approach and the trocar ports positioning and underline the very low blood loss both intraoperatively and postoperatively. We agree with the authors that RATS facilitate neurogenic tumors resection, particularly those in extreme site of the mediastinum as underlined by other investigators (24). The possibility to have interchangeable and precise instruments permits to resect lesion also in small spaces and close to important structures. Finally, the operation timing and learning curve applied to posterior mediastinal tumors are reasonable (25).

Even if the thoracoscopic accesses appear to be the same, when using the robot, there is less fractioning with intercostal nerve, less pain for the patient and consequent lower utilisation of analgesics compared to VATS.

All these aspects can potentially translate into a favourable cost-effectiveness ratio in a near future, when the number of robotic procedures will be substantially increased in thoracic surgery and the new robotic systems will be available on the market with the promise of reducing the costs. To increase the evidence of the benefits of robotic versus manual VATS and open procedures, further experience is required, and prospective comparative studies with assessment of pain, quality of life and costs are needed.

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Footnote

Conflicts of Interest: G Veronesi has financial relationship with Abi Medica, Medtronic and Verb Surgical; M Solinas has no conflicts of interest to declare.

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