Novel perspectives in the surgical treatment of posterior mediastinal masses

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Abstract: Posterior mediastinal lesions represent a relatively small proportion of the case loads in thoracic surgery. As the minimally-invasive approaches to the lung and anterior mediastinum continued to advance and improve, many of those techniques can also be employed for posterior mediastinal lesions. Single-port video-assisted thoracic surgery and robot-assisted thoracic surgery are the two leading techniques in this field. Due to the lower incidence of posterior mediastinal lesions and the heterogeneity of the pathologies, evidence for their application is limited. Nevertheless, the available literature demonstrated high safety and effectiveness of these new approaches for surgical management of posterior mediastinal lesions with satisfactory short-term outcomes comparable to their conventional counterparts. Based on the promising early results, more evidence is expected to consolidate the role of these new techniques for posterior mediastinal lesions.

Keywords: Single-port VATS; video-assisted thoracic surgery (VATS); robot-assisted thoracic surgery (RATS); posterior mediastinum

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Introduction

The surgical approach to posterior mediastinal lesions evolves based on the innovative ideas, accumulation of experience, and advances in instrumentation. Video-assisted thoracic surgery (VATS) has already established its position as a reasonable alternative to thoracotomy for the management of posterior mediastinal tumor (1). This great leap forward in surgical technique allowed shorter hospital stay (2-4), minimal postoperative morbidity, and more rapid recovery (2,4-6). VATS itself is also a continuously evolving technique, with single-port VATS becoming increasingly in vogue nowadays. Its safety and benefits for simple or major pulmonary resections were well-demonstrated (7-9). Robot-assisted thoracic surgery (RATS) has also established its role in pulmonary, pleural and anterior mediastinal surgery. In many ways, their applications are also extendable to posterior mediastinal operations.

Single port VATS

The experience of using single-port VATS for major lung resection has been widely reported in recent years (10,11). The reported benefits, compared with conventional 3-port VATS, includes: lower morbidity (9), shorter chest drain duration (9), shorter length of stay (9), no increased mortality (8) or conversion to thoracotomy (8,9), and less blood loss and postoperative pain (7). Furthermore, the technical challenges of instrument fencing and limited visualization have largely been overcome by advances in techniques, scope and instrument design (12-14) (*Figure 1*).

During the course of single port VATS development, much of the reporting and technical refinement, has been focused on pulmonary or anterior mediastinal operations, which harbours the greater proportion of its practice. Therefore, the studies designed for the posterior mediastinal lesions are scarce. Wu *et al.* reported their experience with

Figure 1 Single-port VATS excision of 4 cm posterior mediastinal schwannoma via a 2.5 cm skin incision using 5 mm 30-degree thoracoscope, 3 mm diameter endo-sucker, and 3 mm diameter endo-diathermy hook.

single-port VATS in mediastinal lesions in 2015 (15). In the semiprone position they employed, the contralateral hand was placed below the neck, the ipsilateral chest was elevated by 30°, and the ipsilateral arm was flexed and abducted to expose the axillary fossa. The single incision was created in the 4th or 5th intercostal space at the anterior axillary line without the need of rib resection or rib spreading. A 5 or 10 mm 30° thoracoscope was placed at the same incision as the working instruments. Among the 29 mediastinal operations performed, eight were posterior mediastinal lesions (four tumor excision and four cyst excision). The mean wound size was 2.9±0.5 cm, mean operation time was 91±32 minutes, and average blood loss was 35±44 mL. There was no operative mortality. No patients required conversion to three-port VATS or open surgery. The postoperative length of stay was 3.0±0.9 days. No tumour recurrence was noted after a follow-up period of 1–13 months. The population size was further enriched to 40 patients in their succession study in 2016, but the number of posterior mediastinal lesions was not reported (16). Although these case series are limited in their sample size, however, their satisfactory short-term outcomes provide good evidence that approaching the posterior mediastinal lesions via single-port VATS is feasible, safe, and effective. With gradually increasing acceptance of single-port VATS for thoracic surgery, it is expected that larger case series or comparative studies for posterior mediastinal lesions will be reported.

Robotic thoracic surgery

Certain disease factors may render VATS technically difficult and mandate open thoracotomy. Tumors that are large and/or adherent, with invasive or intraspinal growth, or at extreme locations (superior-posterior mediastinum or posterior costodiaphragmatic angle) (17,18) creates difficulties in dissection and manipulation of the target lesion via VATS. Removal of such tumors required very accurate dissections to avoid damaging the surrounding neurovascular structures (19). This may be more easily achievable if aided by the robot systems which offers three-dimensional visualization and greater dexterity. Currently, RATS has already been widely applied to most thoracic operations e.g., major lung resections, pleural operations and thymus resection.

In RATS, patients are usually placed in a lateral decubitus position; further forward body tilting may facilitate the lung and blood to fall away from the operative field for better exposure of the posterior mediastinum. The most commonly used robotic device is the da Vinci system (Intuitive Surgical, Sunnyvale, CA, USA). The camera port is usually positioned in the 7th or 8th intercostal space on the posterior axillary line. The posterior port should ideally be placed in the same intercostal space as the camera port. The anterior port is created in the 5th–6th intercostal space on the anterior axillary line. The fourth robotic arm may be added to aid the retraction or suction (20). Carbon dioxide insufflation may be used to further collapse the lung and flatten the hemidiaphragm (21). To allow optimal dissection and manipulation, the placement of the ports should be modified according to the location of the tumor in the posterior mediastinum. For example, if the targeted lesion is at or infero-posterior to the level of the inferior pulmonary vein, the trocars can be placed anteriorly in the mid or anterior axillary line, and then bring in and dock the robot from the dorsal side of the patient (20).

The only large series of RATS for the posterior mediastinum was reported by Cerfolio *et al.* in 2012 (20). The procedure was performed in 75 patients with a wide variety of posterior mediastinal pathologies (e.g., tumors, cysts, diaphragmatic hernia, diverticulum). The robotic system was shown to be safe and effective (operative time 95±25 minutes, median blood loss 50 mL, conversion to thoracotomy 1.3%, morbidity 12%, no operative mortality). The robot docking time and the total operative time showed obvious improvement after 10 cases and 25 cases respectively. After Cerfolio's series, there has been no further significant series or studies to extrapolate the significance of RATS, probably also limited by the relatively smaller incidence of posterior mediastinal lesions and their

heterogeneity in pathology. Moreover, the economic and labour intensiveness of setting up a RATS program is high. The monetary and political commitment to purchase the robot, re-design the operating theatre, and the surgeons' willingness of changing practice are the prerequisites. Additionally, minimally-invasive approach to the posterior mediastinum is intrinsically difficult, regardless of the number of ports and techniques employed, due to the tighter rib spaces posteriorly. To further overcome the technical difficulties and devise the optimal port placements, more efforts are required by the experts in this field to gather and publish their experience and insights. It can also be foreseen that other approaches to resect posterior mediastinal masses may be explored including single port robotic systems, soft robotic systems and even transdiaphragmatic access (10,22-24).

Conclusions

Despite the limited available evidence to mark the advancements in VATS techniques applied to posterior mediastinal lesions, operations via single-port VATS or robot-assisted thoracic surgery are effective, safe and offers satisfactory short-term outcomes. With accumulation of experience and continued technical refinements, minimally-invasive approaches to the posterior mediastinum will gradually establish its role in the treatment of such lesions.

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