REVIEW

Video-Assisted Thoracoscopic Surgery (VATS)

C. Simoglou [1], D. Gymnopoulos [2]

[1]Cardiothoracic Department Medical University of Evros, [2]Private Clinic, Komotini, Greece

ABSTRACT

Video-assisted thoracic surgery is finding an ever-increasing role in the diagnosis and treatment of a wide range of thoracic disorders that previously required sternotomy or open thoracotomy. The potential advantages of video-assisted thoracic surgery include less postoperative pain, fewer operative complications, shortened hospital stay and reduced costs. The following review examines the surgical and anesthetic considerations of video-assisted thoracic surgery.

Keywords: Carcinoma, Bronchogenic, Pneumonectomy, Surgical Procedures, Thoracic Surgery

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INTRODUCTION

Video assisted- thoracoscopy is now a well-established technique in the armamentarium of the thoracic surgeon. Jacobaeus is credited with the technique of thoracoscopy and the first clinical application dates from 1913. He performed adhesiolysis to enhance pneumothorax therapy of tuberculosis via a cystoscope introduced into the pleural cavity. Before the 1990s thoracoscopic surgery was restricted to biopsy procedures, management of pneumothorax, empyema irrigation, sympathetic chain ablation, and removal of intrathoracic foreign bodies. The introduction of video imaging technology and the wider availability of stapling devices facilitated an increasingly wider use of thoracoscopy for diagnostic and therapeutic procedures.

Video assisted thoracoscopic surgery (VATS) is principally employed in the management of pulmonary, mediastinal, and pleural pathology. However, the technique is not performed by thoracic and gastrointestinal surgeons only. VATS is now becoming a useful adjunct in specialized orthopaedic and neurosurgical units for minimally invasive approaches to the spine;

also, many of the procedures performed in adults are now described in the paediatric population too. "Medical" thoracoscopy (as opposed to video assisted "surgical" thoracoscopy) is used exclusively for diagnostic purposes and has the advantage that it can be carried out under local anaesthesia or conscious sedation in an endoscopy suite. These latter specialized uses are not further considered below.

Over the last 15 years, advances in the field of minimally invasive surgery have radically transformed surgical practice. The first clinical application of thoracoscopy has been attributed to Hans Christian Jacobaeus who inserted a rigid cystoscope into the pleural cavity to cauterize adhesions and facilitate lung collapse in the treatment of tuberculosis in 1910. It was not until 1992 that Landreneau and colleagues laid the technical and strategic foundations of modern video-assisted thoracic surgery (VATS) thereafter, the rediscovery of thoracoscopy and its growing use enabled increasingly complex operations to be performed, which had hitherto only been possible by thoracotomy. At an international symposium on thoracoscopic surgery held in January 1993 in San Antonio, Texas, it became clear that many of the simplest videothoracoscopic surgical procedures would rapidly become the gold standard for the treatment of certain pathologies. Bronchogenic carcinoma is the leading cause of cancer-related death in men. Preoperative TNM staging of non-small-cell lung cancer is essential for establishing both the prognosis and therapeutic strategies available. Complete surgical resection, traditionally performed via thoracotomy, is considered the treatment of choice. However, recent progress in VATS has led to this approach assuming a major role in many aspects of the treatment of lung cancer. The objective of this paper is to examine the current indications for videothoracoscopy in the management of lung cancer. This minimally invasive technique can be used in the evaluation of solitary pulmonary nodules and final staging of tumors, pleural and lymph node metastases; staging includes intrapericardial tumor evaluation to determine the feasibility of tumor resection as a first step in lung cancer surgery.

INDICATIONS

The VATS approach was initially used for simple diagnostic and therapeutic procedures involving the pleura, lungs, and mediastinum [1]. However, VATS operations continue to replace many procedures that formerly required thoracotomy [2]. For example, pulmonary operations using VATS have evolved from simple wedge and segmental resections to complete lobectomy. In selected patients a VATS lobectomy is a reasonable treatment option to thoracotomy for both adults and children [3, 4]. VATS operations can be used for all structures in the chest, and are not limited to the lungs, pleura and mediastinum (Fig.1). The heart and great vessels, the esophagus and diaphragm, the spinal column and nerves can all be operated on using VATS [5 ± 13]. Each year has seen new, innovative applications of the technique. For example, intractable pain as a result of chronic pancreatitis can now be treated by inactivation of the major afferent pain nerves with the use of thoracoscopic splanchnicectomy [4].

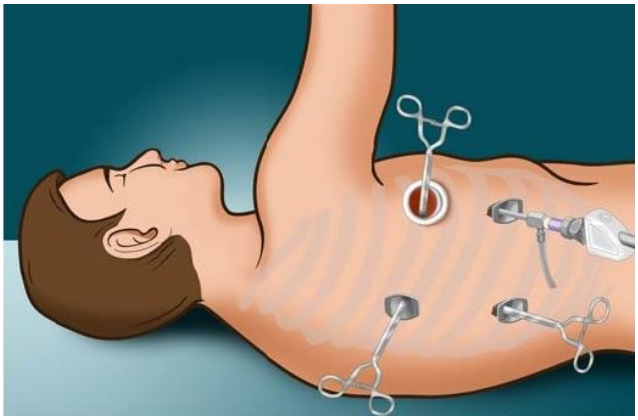


Figure 1. In VATS, the surgeon makes three to four small incisions (ports), and uses a telescope to see inside the chest, without any retractors or rib spreading. One of the ports (arrow) needs to be large enough (about one and a half inches) to fit the lobe of the lung containing the tumor.

THE CONDUCT OF VATS

The procedure is performed under general anaesthesia with the patient in a lateral decubitus position. Anaesthetic management is not different from the open procedures. Single lung ventilation with collapse of the ipsilateral lung is necessary. Carbon dioxide insufflation is very rarely required. A set of surgical instruments should be available on stand-by in case it is needed to convert to thoracotomy. For minor procedures three 1 cm incisions are used for the corresponding "ports", thus allowing triangulation of the instruments: the camera is usually placed in the central port and the other two are used for biopsy and retraction instruments. Various stapling devices or the Nd:YAG lasers are invaluable adjuncts in more complex procedures. Patients with previous thoracotomies or with a history of extensive pleural disease are not good candidates for VATS [5]. However, this is not an absolute contraindication, since the adhesions can be dealt with thoracoscopically, with the lung eventually collapsing and allowing good visibility. With the new technology the quality of view is excellent, and this compensates to some extent for loss of tactile feedback. Markedly unstable or shocked patients represent absolute contraindications. Other patient factors which can make the thoracoscopic approach difficult or impossible are obesity or increased thickness of the chest wall, narrow rib spaces, a small chest or underlying conditions associated with increased bleeding, the blood obscuring the lens, or absorbing light.

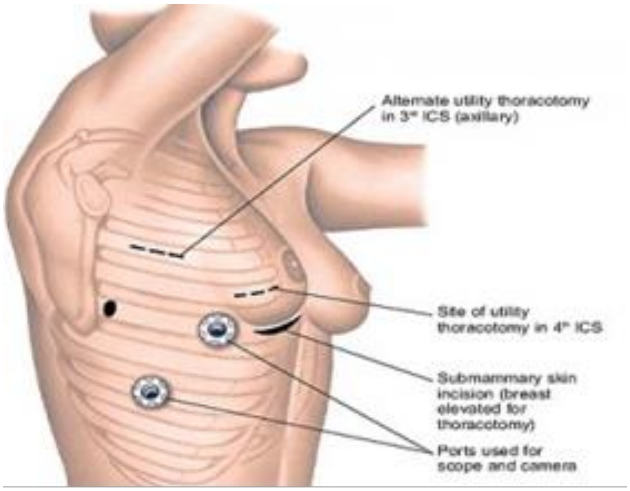
VATS FOR LUNG CANCER

The VATS approach allows the surgeon to access the problem area by using an endoscope and other small endoscopic instruments and endostaplers. These small instruments can be inserted into the chest through small 2-4 cm incisions made between the ribs. The scope allows the surgeon to view, under high magnification, the cancerous lung tissue and manipulate the instruments to effectively transect and remove the tissue from the body [3, 6].

CANDIDATES FOR VATS LOBECTOMY

Not all patients are candidates for VATS lobectomy. The classic indication for a VATS approach to lobectomy is early stage lung cancer in which the primary tumor is 3 cm or less in diameter and located toward the periphery of the lung parenchyma. Tumors

that are located close to the major blood vessels or airway where these enter the lung or larger tumors associated with tumor spread to lymph nodes in the central regions of the lung may require the enhanced tactile input afforded by thoracotomy to make sure the tumors are resected with a negative margin, that the tumor is surrounded completely by a margin of non-cancerous tissue, and that arteries and airways to portions of the lung that are not being removed are preserved intact. In addition, patients who have had pre-operative chemotherapy or radiation for lung cancer or previous chest surgeries may not be candidates for VATS due to scarring around the major blood vessels that makes dissection via VATS difficult [7]. Cases in which a lung tumor invades the chest wall and an en bloc resection of ribs must be performed to achieve negative resection margins generally are felt to abrogate the value of VATS. Finally, pneumonectomy by VATS, though it has been reported, is generally not performed because the size of the specimen requires a large incision with or without rib spreading for removal, abrogating the value of VATS [8] (Fig. 2).



VATS FOR LUNG CANCER SURGERY

VATS lobectomy is the same as lobectomy performed via thoracotomy in that the pulmonary artery, pulmonary vein, and bronchus to the involved pulmonary lobe are individually dissected, ligated and divided. Generally, endoscopic stapling devices are used to ligate and divide the vessels and the bronchus however conventional suture material can also be used. During VATS lobectomy, the structures being operated on are not directly visualized with the naked eye but are visualized solely with a fiberoptic thoracoscope. A camera attached to the thoracoscope transmits the image to a video screen, which allows surgeons and assistants to observe the flow of the operation. Surgical specimens are placed into a water-tight bag and removed from the chest without morcellization (i.e. breaking up the specimen into small pieces before removal); this prevents seeding of the VATS incisions with tumor cells and allows for an intact specimen for pathology examination and cancer staging. Removal of lymph nodes from the mediastinum is not compromised by VATS and remains a cornerstone of the surgical therapy of lung cancer. Visualization is enhanced due to the magnification afforded by the fiberoptic thoracoscope and a 30 degree angle of visualization aids in looking around corners. However, because the incisions are too small to allow passage of the surgeon's hands into the thorax, the surgeon's tactile input is compromised. VATS operations rely on a thorough understanding of pulmonary anatomy to allow for strategically placed incisions (usually 3-5 incisions total). The main advantages of VATS over thoracotomy are that major

muscles of the chest wall are not divided and rib spreaders that can lead to rib fractures or costovertebral joint pain are not used. This results in a hospital length of stay after VATS lobectomy generally reported to range from 3–5 days, or roughly half that for lobectomy via thoracotomy [9].

LUNG VOLUME REDUCTION SURGERY

A special indication for VATS is lung volume reduction surgery (LVRS). LVRS procedures improve dyspnea and pulmonary function in selected patients with severe emphysema [10]. A thoracoscopic LVRS procedure can avoid the significant morbidity and mortality associated with similar operations performed by thoracotomy or sternotomy. Staged LVRS operations offer no advantage over a single hospitalization for bilateral LVRS [11]. Patients undergoing bilateral lung volume reduction via median sternotomy were compared with patients undergoing the procedure by bilateral VATS [12]. Although the operating time was longer for the VATS operations, blood loss was significantly greater in the median sternotomy group. In another study comparing LVRS using VATS with sternotomy, sternotomy patients required longer mechanical ventilatory support postoperatively, spent more time in the intensive care unit, had more days with an air leak, and were hospitalized longer. Although both surgical approaches offered equivalent functional outcomes [18 ± 20], the overall hospital costs of a LVRS with the use of the VATS approach are significantly less than those of an LVRS using sternotomy [13].

ANESTHETIC CONSIDERATIONS

The surgical approach to thoracoscopy involves creating a small (2 ± 3 cm) incision in the lateral chest wall with the patient in the lateral decubitus position. Although minor operations (thoracentesis, pleural biopsy) can be performed through a single incision, two or three additional small incisions are usually made to allow the application of surgical instruments and stapling devices. A trocar is introduced into the chest cavity after the lung on that side has been selectively collapsed. The thoracoscope is then placed through the trocar into chest. At the conclusion of the procedure a chest drainage tube is inserted and the lung is re-expanded. VATS can be performed using either local, regional, or general anesthesia. The simplest technique is to use a local anesthetic to infiltrate the lateral thoracic wall and parietal pleura. Alternatively, intercostal nerve blocks can be performed at the level of the incisions and at two interspaces above and below. Thoracic epidural anesthesia can also be used. For VATS procedures under local or regional anesthesia, an ipsilateral stellate gang- lion block is often performed to inhibit the cough reflex from manipulation of the hilum. To anesthetize the visceral pleura, topical local anesthetic agents can be applied. Intravenous sedation with propofol may be needed to supplement the regional nerve blocks [14]. For VATS performed under local or regional anesthesia with the patient breathing without assistance, partial collapse of the lung on the operated side occurs when air is allowed to enter the pleural cavity. The resulting atelectasis may provide suboptimal surgical exposure. To facilitate visualization, carbon dioxide can be insufflated under pressure

into the chest cavity to compress the non-ventilated lung. This may cause serious respiratory and hemodynamic changes. Gas insufflations can result in an increase in airway pressure, a rise in end-tidal carbon dioxide, mediastinal shift with hemodynamic instability and a drop in systolic blood pressure, and a decrease in hemoglobin oxygen saturation despite ventilation with 100% oxygen [15]. This clinical presentation resembles a tension pneumothorax. These physiological responses to carbon dioxide insufflations into a closed chest cavity occur with pressures as low as 5mm/mg [16, 17]. The complication can be reduced if the volume of gas is limited to 2 l/min and the carbon dioxide is insufflated slowly. The major disadvantage of VATS under local or regional anesthesia is that the patient must breathe spontaneously.

This is usually tolerated for short periods of time, but for most VATS procedures a general anesthetic with controlled one-lung ventilation (OLV) is a better choice. A single-lumen endotracheal tube (ETT) can be used for VATS under general anesthesia [18]. However, if the lungs are not separated, positive-pressure ventilation to both lungs prevents lung collapse on the operated side, with inadequate surgical exposure. Therefore, lung separation with selective OLV to only the contralateral side is usually indicated. The lung must be completely collapsed to provide optimal surgical conditions [19]. Failure to separate the lungs, with partial in¯ation of the operated lung, will jeopardize the operation and may make open thoracotomy necessary. A double-lumen endobronchial tube (DLT) or bronchial blocker should be used to collapse the lung. A DLT is preferred because it provides selective ventilation of the contralateral lung, while allowing more rapid collapse of the ipsilateral lung [20]. Carbon dioxide insufflation to compress the lung further is seldom needed. Opening the lumen of the DLT on the operated side to room air, and intermittently suctioning the tube further augments lung collapse. A DLT also allows the lung to be rexpanded under direct vision with a DLT. General anesthesia for VATS is achieved with either intravenous or inhalational anesthetic agents, or a combination of both. The use of shortacting intravenous agents is important to allow the rapid emergence and recovery of airway reflexes [21].

POSTOPERATIVE ANALGESIA

There is less postoperative pain after VATS than after similar operations performed by thoracotomy [22]. Although a potential benefit of VATS is the reduction of postoperative pain related morbidity, further studies are needed to define the relative costs, risks and benefits of standard post-thoracotomy analgesic management using epidural opioids with less aggressive pain management after VATS [23, 24]. For VATS, local anesthetic solutions can be infiltrated at the chest wall incision sites and administered as a bolus or by continuous infusion into the pleural cavity through the chest tube after the lung has been re-expanded. Post-thoracoscopy pain can also be treated with systemic or neuraxial opioids. Patient-controlled intravenous opioid analgesia is preferred. Thoracic or lumbar epidural opioids provide superior pain relief, but

because of their side-effects are seldom indicated. Transcutaneous electrical nerve stimulation is also effective in reducing analgesic requirements after VATS and a role exists for non-steroidal anti-inflammatory drugs after VATS. Both diclofenac and ketorolac were equally effective in reducing intravenous morphine requirements after VATS [25].

COMPLICATIONS

Approximately 9% of VATS patients experience some complications [26]. These include hemorrhage, subcutaneous emphysema, empyema, recurrent pneumothorax, pulmonary edema and pneumonia. Dissemination of tumor at the thoracostomy tube site is also possible. Persistent postoperative air leaks are quite common. Any structure that the surgeon manipulates or resects can be damaged. Some patients may experience impaired gas exchange during and after the procedure. The pneumothorax created during VATS, especially when associated with carbon dioxide insufflations into the closed chest, can result in hypercarbia and inadequate ventilation, hemodynamic instability, and even gas venous embolism. Common to all VATS procedures is the need to be able to convert rapidly to an open thoracotomy when necessary. Atrial arrhythmias, especially supraventricular tachycardia and atrial fibrillation can occur after all pulmonary resections and the incidence is similar after VATS or thoracotomy.

CONCLUSION

Within a relatively short period of time, VATS has replaced many diagnostic and therapeutic procedures previously performed by traditional thoracotomy. By minimizing chest wall and muscle trauma, VATS not only causes less postoperative pain and fewer complications but also shortens hospital stay. VATS techniques continue to evolve and the refinement of instrumentation promises further applications for selected conditions. The anesthetic management of VATS involves the ability to separate the lungs to provide safe and effective OLV. The long-term role of VATS awaits studies of the economics, indications and end results of the specific applications of this technique.

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ΑΝΑΣΚΟΠΗΣΗ

Βίντεο-υποβοηθούμενη Θωρακοσκοπική Χειρουργική (Video-assisted thoracoscopic surgery, VATS)

Χ. Σίμογλου[1], Δ. Γυμνόπουλος[2]

[1]Χειρουργική Κλινική Καρδιάς-Θώρακος, Πανεπιστημιακό Γενικό Νοσοκομείο Έβρου, [2]Ιδιώτης Ιατρός, Κομοτηνή

ΠΕΡΙΛΗΨΗ

Η θωρακοσκοπική χειρουργική τεχνική είναι η εξεύρεση που ολοένα αυξάνει τον ρόλο της στη διάγνωση και θεραπεία σε ένα ευρύ φάσμα παθήσεων του θώρακα που προηγουμένως απαιτούταν στερνοτομή ή ανοιχτή θωρακοτομή. Τα πιθανά πλεονεκτήματα της χειρουργικής τεχνικής αυτής περιλαμβάνουν λιγότερο μετεγχειρητικό πόνο, λιγότερες μετεγχειρητικές επιπλοκές, μικρότερη νοσηλεία και μειωμένο κόστος. Τούτη η ανασκόπηση εξετάζει τις χειρουργικές και αναισθησιολογικές εκτιμήσεις της θωρακοσκοπικής χειρουργικής θώρακος.

Λέξεις ευρετηρίου: Βρογχογενής Καρκίνος, Πνευμονεκτομή, Χειρουργικές Επεμβάσεις, Χειρουργική Θώρακος

Παραπομπή

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Συγγραφέας επικοινωνίας

Χρήστος Σίμογλου, E-mail addresses: simoglouchristosdoctor@yahoo.com