Video assisted thoracoscopic surgery

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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 specialised 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.[1] These latter specialised uses are not further considered below.

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.[2] 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.[2 3]

Diagnostic procedures

PLEURAL DISEASE

For patients with pleural effusions, thoracentesis should be the first line of management. The fluid is sent for biochemical, cytological and microbiological analysis, further studies depending on whether the fluid is an exudate or a transudate. Exudates can be broadly divided into infectious and non-infectious and require further investigation. A combination of thoracoscopy and lung/pleural biopsy usually reaches the final diagnosis. Malignant pleural effusions, primary or metastatic, are particularly suited for diagnosis by thoracoscopy, as the disease is focal rather than uniform and blind biopsies tend to have a low yield.[4 5]

INTERSTITIAL LUNG DISEASE

Despite diagnostic efforts by sputum analysis, bronchoscopy, bronchoalveolar lavage, and transbronchial biopsy, some parenchymal infiltrates remain idiopathic. In such instances surgical biopsy is indicated, the thoracoscopic approach being generally superior to the open techniques.[5–7]

PULMONARY NODULES

Solitary pulmonary nodules can be malignant in up to a third of cases and tissue diagnosis is therefore a mandatory end point. Percutaneous biopsy aided by various localisation techniques still produces a too high rate of false negative results. The data of Calhoun *et al* showed that after a fine needle percutaneous biopsy a specific diagnosis of benignity is reached in less than 5% of cases.[8] It follows logically that surgical excision is a safer option, with thoracoscopy ideally suited for nodules in the outer third of the parenchyma. Nodules that appear to be seated deeper in the parenchyma on imaging can actually be very close to the surface in a fissure and these too are readily accessible. Bleeding and conversion to thoracotomy or pulmonary haematoma complicate resection of more central lesions for diagnostic purposes.[9] As there is no tactile capacity with VATS, a common situation is that the nodule is not easily found even if it is situated peripherally. Despite recourse to localisation techniques, such as palpation devices, ultrasound probes, needle guidance and preoperative injection of a dye marker, conversion to the open procedure is sometimes required.[9] In

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cases where frozen section histology of a thoracoscopically extracted specimen confirms malignancy, the surgeon can proceed to completion of the excision via the minimally invasive route or formal thoracotomy (see discussion below).

MEDIASTINAL MASSES

Paratracheal and subcarinal lymph nodes are accessible by cervical mediastinoscopy. The masses and lymph nodes situated in the aortopulmonary window and pulmonary hila used to be assessed by anterior mediastinotomy (the Chamberlain procedure). VATS is superior to mediastinotomy, in that it is less invasive and provides access to other areas too, such as the posterior mediastinum. Routine prethoracotomy mediastinal exploration in patients with confirmed lung cancer is advocated by some groups, especially if multifocal lesions are suspected or to assess invasion of chest wall or other adjacent structures. This policy reduces the number of "open and close" thoracotomies to a minimum.[10]

Therapeutic procedures

PLEURAL DISEASE

Benign effusions usually disappear when the underlying disease is successfully dealt with. Malignant effusions are by definition associated with unresectable disease (T4 in the tumour, node, metastases (TNM) classification). If the lung retains the capacity to re-expand, tube thoracostomy and chemical pleurodesis with tetracycline can be sufficient. If the diagnosis is established by thoracoscopy, additional options include mechanical abrasion, instillation of talc or other sclerosants, and pleurectomy.[5] The magnitude of the latter makes it unsuitable for this group of debilitated patients. In more advanced disease the effusion recurs or the lung becomes trapped. The same measures of tube thoracostomy, or thoracoscopy in better risk cases, can be reapplied but the chances of success are less as the disease progresses.

VATS is useful in the intermediate phase of empyema, before the lung is encased in a thick fibrous peel that would require open decortication.[11] In this fibropurulent phase tube drainage is unsuccessful if loculations are present, and thoracoscopic adhesiolysis is an attractive option.

VATS is increasingly employed in the management of stable trauma patients.[12 13] In the acute phase, thoracoscopy is useful in establishing the magnitude of lesions and achieving haemostasis. In the subacute setting, inadequately drained haemothoraces are associated with an increased risk of empyema and fibrothorax. If thoracoscopy is used at an early stage for removal of clot, this can prevent a subsequent open procedure for decortication. Associated injuries, such as those of the diaphragm, can be identified and dealt with thoracoscopically.[14]

In cases of chylothorax with failed conservative management a VATS procedure is less invasive than a thoracotomy and can be successful in repairing or ligating the lymphatic duct.[15]

BULLOUS LUNG DISEASE

Primary spontaneous pneumothorax occurs in patients without underlying lung disease. It is caused usually by rupture of an apical bleb in a young adult. Spontaneous secondary pneumothorax occurs in a different age group; the patients have underlying pulmonary pathology, the most common being emphysematous bullae. Removal of blebs and bullae can be achieved thoracoscopically with endoloops or endostaples. The advantage over the formal thoracotomy is that there is better view, an apical pleurectomy or mechanical abrasion is easily performed and the surgical indication can be extended to a number of patients that are not fit enough for an open procedure.[16 17] One potential disadvantage in emphysematous patients is air leakage from the staple line; this can be reduced by buttressing the staples with various materials including pericardium, Teflon, polydioxanone, and polyglycolic acid.[3] Lung volume reduction surgery by excision of giant bullae can be performed in carefully selected cases with good results.[18 19]

LUNG RESECTION

The principal roles of VATS in lung cancer are diagnosis of the indeterminate pulmonary nodule, staging of the pleura and mediastinum, wedge resection of early tumours in debilitated patients, lobectomy/pneumonectomy, and treatment of malignant pleural effusion.[20]

Some of the above indications have been detailed in the previous discussion. The data from the Lung Cancer Study Group showed that for stage I lung cancer there is no survival benefit of lobectomy over non-anatomical wedge resection.[21] However, there is a significantly higher rate of local recurrence after wedge resection, so this procedure is reserved for patients who are too debilitated to tolerate a formal oncological resection. Resection of solitary metastases is a good indication for VATS, but excision of multiple metastases as, for example, those of osteogenic sarcoma is best accomplished via a conventional thoracotomy that allows palpatory detection of small nodules.[3]

Lobectomy and pneumonectomy can now be performed thoracoscopically, with the possibility of excising the ipsilateral lymph notes as necessary. Ideally the tumour should be small, located peripherally, preferentially in the lower lobes.[20] Potential disadvantages include the loss of tactile sensation in deciding upon the extent of resection, the risk of significant intraoperative or postoperative haemorrhage, and prolonged operative time. To avoid the risk of tumour seeding, the excised lesion is placed in a plastic bag within the pleural cavity and then extracted through a minithoracotomy. Pneumonectomy is usually required for advanced lesions with hilar involvement, and this in itself militates against a minimally invasive approach. However, there have been many reports of successful pneumonectomies in

selected cases with small central lesions.[22] VATS lobectomy still has to prove its superiority over the conventional open procedure before it is more widely accepted. It is speculated that a smaller degree of tumour manipulation produces less derangement of the immune function, but better survival results are awaited to confirm this hypothesis. It cannot be overemphasised that there should be no compromise in the extent of resection by the minimally invasive route; conversion to thoracotomy should be considered sound judgment and not failure of VATS in case adequate clearance of tumour and lymph nodes cannot be achieved.[20]

MEDIASTINUM

It has already been mentioned that VATS is complementary to cervical mediastinoscopy in assessing lymphadenopathy in the mediastinum. VATS pericardiectomy is a form of treatment for recurring benign or malignant pericardial effusions in which the more conventional catheter pericardiocentesis or subxiphoid window failed.[23] Small mediastinal masses can be removed thoracoscopically from different locations in the mediastinum.[24] The vast majority of mediastinal cysts are benign and do not require removal unless they cause compression symptoms or there is diagnostic doubt. Experience of thoracoscopic excision is accumulating in this domain too.[25] Likewise, thymic tumours can be excised thoracoscopically, but the procedure is technically demanding and at the present time remains experimental in dedicated centres.[26] VATS can be used for both staging and definitive treatment of oesophageal cancer.[27–29] Thoracoscopic resection of oesophageal cancer is a technical challenge that was overcome in early 1990s and duplicated in small series ever since, the latest from Law *et al*[28] and Dexter *et al*[29] including 22 and 24 cases respectively. However, the need for a judicious oncological resection and the increased risk of complications with a minimally invasive approach have failed to gain the procedure a wider popularity. There is wider scope for thoracoscopic surgery in benign oesophageal conditions, for example resection of benign solid tumours or epiphrenic diverticula and intrathoracic antireflux surgery.[27]

AUTONOMIC NERVOUS SYSTEM

Truncal vagotomy is a rare operation nowadays; when indicated, it seems logical to perform it via the minimally invasive thoracoscopic route.[30] Similarly, thoracic splanchnicectomy for patients with intractable pain from chronic pancreatitis or pancreatic cancer has been reported.[31] Accepted indications for sympathectomy include pain syndromes of the upper limb and hyperhydrosis.[32 33] Preoperative response to a stellate ganglion block is a prerequisite to ensure a good result from the planned sympathectomy. The advantage of VATS over the cervical approach include access to lower autonomic stations (that is T4) and avoidance of the important neurovascular structures in the neck region. Vasospastic disorders have been treated with sympathectomy but with less rewarding results.

Conclusion

The advantage of VATS over thoracotomy lies in the reduction of both acute and chronic postoperative pain. This was demonstrated in several studies, together with earlier return to normal activity.[3] In terms of costs, VATS is an expensive undertaking but several studies demonstrated a reduced high dependency and hospital stay which probably neutralise the expense.[34] Adequate exposure of surgeons over a gentle learning curve is essential before embarking on increasingly complex procedures.

It is logical that the complications of thoracoscopy are by and large related to the surgical complications of the treated condition and from this point of view are similar to those that follow conventional open operations. The necessity to convert a thoracoscopic procedure to an open one stems from one of the following: significant adhesions, uncontrollable bleeding, inadequate view, inability to obtain single lung ventilation, removal of large lesions, and inability to perform an adequate excision.[2]

It can be seen from this overview that most thoracic operations can be tackled in this day and age thoracoscopically. Many series and case reports enthusiastically illustrate that more and more procedures can be performed via the minimally invasive route. The debate will soon shift from the anecdotal "it can be done" to the subtler "should it be done?" Few randomised trials are available to scientifically answer specific questions, especially related to long term patient outcomes, and this is not surprising for a relatively new technique. The available studies suggest that simple parenchymal sampling, wedge resection, and pneumothorax surgery are best performed thoracoscopically. Selected cases of lung volume reduction are also suitable for VATS. More controversial is the role of VATS in cancer resection, but the minimally invasive and conventional techniques should be seen as complimentary and not opposed. The minimally invasive approach is best reserved for peripheral early tumours, while the more advanced and central lesions will be managed by open resection in the foreseeable future. The debate over patient outcomes and cost effectiveness should continue until the practice becomes more standardised.

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