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Peri-operative complications of video-assisted thoracoscopic surgery (VATS)☆

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ABSTRACT

Video-assisted thoracoscopic surgery (VATS) has multiple indications for diagnosis and treatment of many different thoracic diseases; the commonest are lung wedge resection, pleural and mediastinal biopsy, treatment of pneumothorax, and pleurectomy. Moreover, in recent years a few surgeons have performed routinely major lung anatomic resections by VATS approach, including segmentectomy, lobectomy and pneumonectomy.

In our experience VATS constitutes about one-third of all thoracic surgical procedures. In the reviewed literature as in the most frequent complications after VATS procedures are: prolonged air leak, bleeding, infection, postoperative pain, port site recurrence and the need to convert the access in thoracotomy. The complication and mortality rates are generally very low and VATS procedures are considered safe and effective.

It is recommended that all thoracic surgery departments audit their VATS procedures for peri-operative morbidity and mortality to compare results and outcomes.

1. Introduction

Video-assisted thoracoscopic surgery (VATS) procedures have proved to be safe and effective for treatment of a large variety of thoracic diseases, with low peri-operative complication rates as reported in several large series of patients. Fifteen years after the beginning of the widespread application of VATS, this paper reviews the complications associated with VATS procedures.

2. Overall morbidity and mortality after VATS

In three large studies published in 1996 the overall complication rates after a variety of VATS procedures were, respectively, 4%,[1] 4.3%[2] and 3.7%,[3] with no reported deaths attributable to the VATS technique. Similarly, in the very large series reported by the Video Assisted Thoracic Surgery Group (55 surgeons from 40 institutions who performed general thoracic surgery as the majority of their practices),[4] the complications observed in 1358 patients undergoing VATS procedures were: air leak longer than 5 days in 3.2% of patients; atelectasis in 1.4%; arrhythmia in 1.3%; bleeding in 1.2% (one-third required transfusion); pneumonia in 1.1%; prolonged ventilator dependence in 1.0%; empyema in 0.6%; and wound infection in 0.4%. There were no intraoperative deaths, and the total postoperative mortality rate for the 1358 patients was 2.0% (27 patients). Causes of deaths were sepsis in seven patients, respiratory insufficiency in four, progression of malignancy in three, pneumonia in two, renal failure in two; and hepatic failure, cardiac arrest, pulmonary embolus, and stroke occurred each in one patient.

In our Center for Thoracic Surgery at the University of Insubria in Varese, after reviewing 1093 consecutive VATS procedures performed from 1996 to July 2008 we recorded the following complications: prolonged air leak in 4.7% of patients; pneumonia in 2%; bleeding (with blood transfusion) in 2%; and wound infection in 0.6%. Conversion to thoracotomy was necessary to complete the procedure in 1.7% of cases; the peri-operative mortality was 0.6% (seven patients died in the postoperative period due to: respiratory failure (four patients), pneumonia (one patient), acute cardiac disease (one patient), sepsis (one patient)).

Table 1 summarizes the main complications observed in seven large series of VATS procedures and shows that the most prevalent are prolonged air leak and bleeding, while other complications are infrequent.[1–7] We will analyse separately the prevalence and feature of these complications of VATS procedures.

Abbreviation: VATS, Video-assisted thoracoscopic surgery.

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Table 1
Postoperative complications after VATS procedures (case-mix and procedures differ) in International series.

References	No. of patients	Prolonged air leak	Bleeding	Wound infection	Death
		(%)	(%)	(%)	(%)
Krasna et al.[1]	348	3 (0.9)	3 (0.9)	n.d.	nil
Yim and Liu[2]	1337	21 (1.6)	6 (0.4)	13 (0.9)	1 (0.1)
Jancovici et al.[3]	937	63 (6.7)	18 (1.9)	n.d.	5 (0.5)
Downey[4]	1358	43 (3.2)	16 (1.2)	5 (0.4)	27 (2)
Inderbitzi and Grillet[5]	5280	93 (1.8)	23 (0.4)	n.d.	16 (0.3)
Kaiser[6]	266	10 (3.8)	5 (1.9)	5 (1.9)	n.d.
Hazelrigg et al.[7]	1820	43 (3.2)	21 (1.6)	21 (1.6)	nil
Imperatori (2008)	1093	51 (4.7)	22 (2)	7 (0.6)	7 (0.6)

n.d. = not determined.

3. Prolonged air leak

Prolonged air leak is the most prevalent complication of VATS and is more likely to occur after resection of lung nodules and bullae.

After VATS lung biopsy, moderate air leakage from parenchyma which has been sutured or biopsed or traumatized by instruments occurs frequently. The thermal injury of electrocautery may also predispose to prolonged air leak. As most patients can be discharged within 48 h, persistent air leak should be avoided. Endoscopic stapling instruments of various sizes may be used to staple and to resect leaking parenchyma. In the operating room, as the lung is inflated, staple lines should be visualized for bleeding and air leak. Even after complete control of air leakage, at the end of each VATS procedure it is advisable to place routinely a chest tube, under direct vision, to provide drainage of any subsequent air and fluid losses. As pointed out by Adebonojo the definition of "persistent air leak" is arbitrary.[8] Indeed, postoperative air leak has been reported with many different lengths of leakage (5–10 days), which makes comparison of results difficult.

In different large series prolonged air leak was reported, respectively, in 3.2%,[4] 3.7%,[9] 4.7%,[10] and 6.7%.[3] In our experience air leak longer than 7 days after 1093 VATS procedures occurred in 51 patients (4.7%).

4. Bleeding

VATS usually offers an excellent visibility of the operative field, thus intrathoracic haemorrhage is rare. Bleeding occurs infrequently when an experienced surgeon performs the procedure; it is more likely to occur in patients with dense adhesions. Bleeding from one of the main pulmonary vessels during VATS, however, can be very dangerous because haemorrhage is sudden and massive and control is limited by the small access.[10,11] Indeed VATS lung resections of any type are contraindicated in patients with tumours near the pulmonary hilum; VATS should be limited to biopsy for diagnosis and a sponge stick should be available to apply pressure immediately for controlling haemorrhage. With bleeding temporarily controlled, a decision is immediately made as to whether thoracotomy is needed. Severe parenchymal haemorrhage may require open thoracotomy and lobectomy for control. Haemorrhage may also derive from trocar site access or from lung biopsy, but these are uncommon events, that are more likely to occur if the patient has a coagulation defect. Depending upon the circumstances, bleeding can be controlled by electro-coagulation, transfixed sutures, metal clips or with linear staplers. Kaiser and Bavaria in 266 VATS reported postoperative bleeding (requiring transfusion) in 1.9% of cases (four patients required thoracotomy).[9] Walker et al. reported a postoperative bleeding rate of 0.5%.[12] In our series of 1093 VATS procedures bleeding occurred in 2% (22 patients required blood transfusion) (Table 1).

5. Infectious complications

The literature data about infections complicating VATS procedures are scarce, in spite of the increased application of VATS in recent years. The few studies available refer to heterogeneous patient populations undergoing various VATS procedures, that cannot be easily compared.[13] Thus the incidence of infections in the VATS setting is not well defined.

Rovera et al. reviewed 346 consecutive VATS procedures and reported about the risk factors affecting the incidence of surgical infection.[14] Patients were divided into two groups: 139 patients undergoing lung wedge resection and 207 patients undergoing intrathoracic biopsy (pleura or mediastinal mass). The following risk factors for infection were assessed: haemoglobin concentration, haematocrit, serum albumin concentration, blood lymphocyte count, length of preoperative stay, duration of surgery, blood transfusion, age, co-morbidity and specifically chronic obstructive pulmonary disease (COPD, measured as FEV1 $<$ 70% of expected). Prophylactic antibiotics were given to more than 90% of patients in both series. The endpoint measures were the occurrence of postoperative infection within 30 days (surgical site infection, pneumonia, empyema) and the final patient outcome. The authors found that one or more postoperative infections occurred in 17/346 patients (4.9%, all of whom had received antibiotic prophylaxis). In the VATS lung resection group the total infection rate was 6.5%, and in the VATS biopsy group it was similar (6.3%). The incidence of surgical site infection was similar in two groups (2.8% vs. 1.0%; p = NS) and the incidence of pneumonia was also similar (2.8% vs. 3.4%, p = NS). All postoperative infections (surgical site, pneumonia, empyema) were treated successfully with antibiotic or antifungal therapy and surgical drainage as indicated. No postoperative deaths occurred. The infection rate in the 50 VATS patients with COPD was significantly higher than in controls (14% vs. 4.9%; $p < 0.01$). COPD was the only univariate predictor of postoperative infection. Indeed FEV1 $<$ 70% of predicted was observed much more frequently in infected patients than in non-infected patients (58% vs. 25%; $p < 0.05$).

6. Postoperative pain

The surgical incisions of open thoracic operations are among the most painful. They cause reduced lung function, impairment of respiratory effort, atelectasis and ultimately hypoxemia. Moreover, pain causes less patient mobilization and increases the incidence of deep venous thrombosis and of pulmonary embolism. Several traumatic factors are known to contribute to *acute pain* after thoracic surgery: tissue trauma and drains, rib fracture and injury to intercostal nerves (due to retractor or trocar). The prominent causes of *chronic postoperative pain* are intercostal neuroma and healing rib fracture. Essentially, in open thoracic surgery pain results from the spreading of retractors.[15]

It has been experienced worldwide that patients have less pain after VATS procedures than after open thoracotomies. Walker compared the requirement for narcotic pain drugs in 83 VATS major pulmonary resection vs. 110 patients who underwent thoracotomy during the same period and found that the VATS group required significantly less morphine ($p < 0.001$).[10] In a randomised prospective trial of lobectomy in 67 patients (47 by VATS and 23 by muscle-sparing thoracotomy) Giudicelli et al. reported that postoperative pain was significantly less ($p < 0.02$) after VATS procedures.[16] Landreneau et al. prospectively evaluated daily narcotic requirements, hospital stay and visual analogue pain scale in 165 patients after muscle-sparing thoracotomy compared with 178 patients after VATS.[17] The latter patients had less pain and greater shoulder strength in the first 6 months postoperatively, but after 1 year the difference disappeared.[17] The severity and duration of pain after thoracotomy obviously depend on the degree of rib spreading and on the site and modality of thoracotomy incision. Indeed, Nomori et al. who compared VATS lobectomy vs. an anterior limited thoracotomy approach, reported that patients in the VATS group experienced much less pain in the first postoperative week, but the difference was not significant subsequently.[18]

Landreneau et al. addressed the problem of chronic pain after pulmonary resection by thoracotomy vs. VATS and found that within the first year after thoracotomy there was a significantly greater increase in the pain reported, as compared to VATS. After 1 year, however, they observed no statistically significant difference in either reported pain level or shoulder dysfunction (VATS 22%; thoracotomy 29%), or narcotic usage (VATS 6%; thoracotomy 16%).[17]

7. Port site recurrence of tumour

Dissemination of thoracic tumours as a result of biopsy or thoracotomy for resection with curative intent is rare. It has been described that during VATS neoplastic cells can disseminate and implant, causing tumour recurrence at the port site. This complication has been reported following VATS biopsy of lymph nodes and after pulmonary wedge resection. Yim[19] and Jancovici et al.[3] noted an increased risk of local recurrence at the thoracoscopy port sites when a retrieval device (glove or bag) was not used. They further noted that recurrence occurred more likely in operations for selected tumour types, namely mesothelioma, metastatic sarcoma and melanoma, or when malignant pleural effusion was present. Mesothelioma is well known to invade thoracic incisions of all types, including thoracotomy, needle biopsy tracks and chest drain sites; similarly, malignant pleural effusions have been shown to implant and cause recurrence in the thoracic wall at the drain sites. In the surgical management of early stage tumours, however, dissemination and chest wall implant of thoracic malignancy resulting for manipulation is a phenomenon rarely observed.

After VATS lobectomy McKenna et al. in 1998 reported a very low incidence of this complication: 1/298 patients of his series (0.3%) developed chest wall recurrence in the utility thoracotomy incision.[20] Subsequently the same authors reviewed their further experience with VATS lobectomy including 1100 cases and confirmed that the recurrence rate in the incision was very low (0.57%).[21] Also in the experience of the Memorial Sloan-Kettering Cancer Center Thoracic Service the prevalence of port site tumour recurrence was very rare: 1/374 patients (0.26%).[22]

8. Conversion to thoracotomy

In 321 patients undergoing VATS procedures for various indications Krasna et al. reported the need to convert to thoracotomy in 8% of cases.[1] Most commonly the conversion to thoracotomy was deemed necessary because of oncological reasons, such as centrally located tumours requiring vascular control or sleeve resection, or unexpected T3–T4 tumours that infiltrate to the chest wall, diaphragm or superior vena cava. Abnormal hilar nodes with granulomatous or metastatic disease adherent to the superior pulmonary vein may be better evaluated and more safely resected with thoracotomy. In the experience of Krasna et al. about 30% of thoracotomy conversions were for non-oncological reasons, such as pleural adhesions.[1] In the series of the Memorial Sloan-Kettering Cancer Center Thoracic Service conversion to open thoracotomy because VATS was not technically adequate occurred in 44/410 patients (11%).[19] In our experience of 1093 VATS procedures, conversion to thoracotomy was done in 19 patients (1.7%), for one of the following reasons: inability to localize precisely the lesion to biopsy or resect; bleeding that was difficult to control; and extensive pleural adhesions.

9. Conclusions

Video-assisted thoracic surgery (VATS) has been widely used in the diagnosis and management of an heterogeneous population affected by intrathoracic diseases with a low impact on intraoperative and postoperative morbidity, indeed the analysis of the data available in the literature shows that VATS is a reliable and safe approach for the diagnosis and treatment of pulmonary diseases with a low complication rate (less than 10%) and a mortality rate less than 1–2%.[23,24]

In our experience and in the reviewed literature, the most frequent complications after VATS procedures are: prolonged air leak, bleeding, infection, postoperative pain, port site recurrence and the need to convert the access into thoracotomy. Their rate of occurrence is generally low and VATS procedures are considered safe and effective, as witnessed by the fact that they constitute about one-third of all thoracic surgical procedures.

However, to further reduce peri-operative complications, it is necessary to preoperatively identify high-risk patients, to improve modifiable clinical conditions with medical supports, and to adopt a meticulous surgical technique (the most important determinant).

It should be recommended that all thoracic surgical departments audit their peri-operative morbidity and mortality to compare results and outcomes.

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